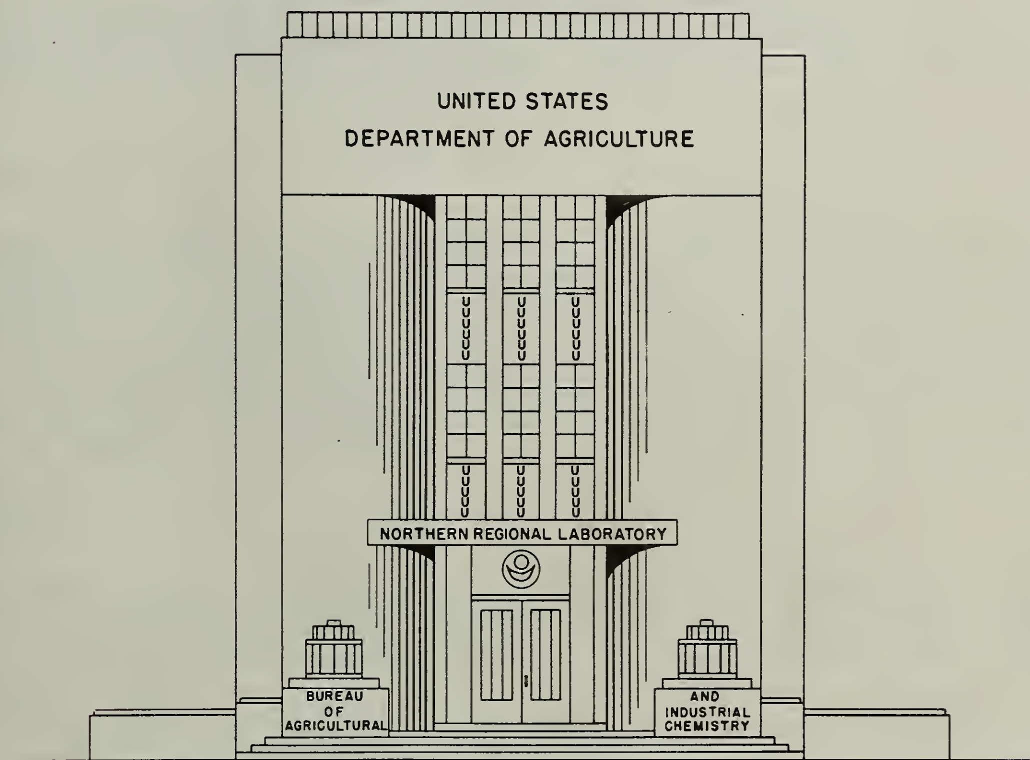
June 30, 1953

THE UTILIZATION OF CEREAL STRAWS IN ITALY, FRANCE, BELGIUM, THE NETHERLANDS, AND ENGLAND FOR THE MANUFACTURE OF BLEACHED PULPS, BOARD, AND FINE PAPERS



Report of trip by Dr. E. C. Lathrop, Head, Agricultural Residues Division, Northern Regional Research Laboratory, U.S. Department of Agriculture, Bureau of Agricultural and Industrial Chemistry, Peoria, Illinois, December 15, 1952 to January 14, 1953

6-30-53
N-53-45

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF AGRICULTURAL AND INDUSTRIAL CHEMISTRY

Northern Regional Research Laboratory
Peoria, Illinois

The Utilization of Cereal Straws in Italy, France, Belgium, the Netherlands, and England for the Manufacture of Bleached Pulps, Board, and Fine Papers

Report of trip taken by E. C. Lathrop, Head, Agricultural Residues Division, to visit paper mills and research laboratories in Italy, France, Belgium, the Netherlands, and England, December 15, 1952 to January 14, 1953.

Purpose:

Advantage was taken of my attendance at the Food and Agriculture Organization of the United Nations Conference in Rome, Italy, December 3-13, 1952 (N-53-20) to remain in Europe for a month longer to familiarize myself with the research and industrial situation concerning the use of cereal straw for paper and board manufacture in the countries of Italy, France, Belgium, the Netherlands, and England, so that the information could be available to the Bureau.

Summary:

During the period December 15, 1952 to January 14, 1953, I had the opportunity of visiting with 34 industrial groups using, or interested in using, cereal straws and other residues in the paper and board industry. Of these, 7 were in Italy, 9 in France, 3 in Belgium, 8 in the Netherlands, and 7 in England. In addition, I visited 7 research institutes interested in this same subject.

The following processes were being used for pulping straw for the manufacture of shipping containers: (1) Pressure processes, using as chemical pulping agents lime, caustic soda, sodium sulfite, sodium sulfite plus caustic soda; and (2) other processes, such as the continuous caustic soda (CELDECOR) and the mechano-chemical process using caustic soda. The poorest products were produced by the lime process, which was the one most widely used. The best product was made by the mechano-chemical process. Trade standards for the quality of shipping containers in these countries are not so exacting as in the United States. Costs of steam and electricity are higher and labor costs are lower, as compared to the United States. Most of the paper machines are narrow, of old design and construction, and very slow running. Many of the pulps used in these countries were so slow in drainage that they would be entirely unacceptable to the strawboard mills in the United States.

The processes developed by the Northern Regional Research Laboratory for the manufacture of shipping container pulps are superior to any processes in the countries visited.

Bleached straw pulps are being manufactured and used as blends with wood pulps to manufacture a wide range of fine papers in Italy, France, the Netherlands, and England. For this purpose, the following processes are being used: Neutral sulfite (NRRL), in the Netherlands, France, Italy; neutral sulfite (continuous Kamyr), in Italy; sulfate process, in the Netherlands; caustic soda-chlorine (CELDECOR), in Italy, France, the Netherlands, England; conventional pressure caustic soda, in England. The highest yields of bleached pulps are being obtained by the neutral sulfite NRRL process. The strongest pulps are probably being obtained by the sulfate process. It is believed that none of these pulps are of as high quality or are obtained in as high yield as have been obtained in commercial trials of the neutral sulfite or mechano-chemical processes by the Northern Laboratory. Samples of most of these bleached pulps have been shipped to Peoria where they will be subjected to chemical and physical tests for comparison purposes.

All of these bleached straw pulps are slower draining than pulps made by the Northern Laboratory processes because of two conditions: (1) In most cases very small fibers, such as compose nodes, are retained in the pulps; and (2) many of the pulps are chemically hydrated due to the cooking conditions, which are more drastic than required to produce high yields of strong pulps. This is partly due to the viewpoint of the papermakers in these countries. The effort is to produce fine papers of good formation and finish. Slow paper machine operation favors this. Most of the paper machines are old, slow operating, and are not capable of the operation speed of American machines producing similar papers. In part, the processes attempt to make a pulp like esparto, which is cooked severely to eliminate pentosans and give a bulky, opaque pulp.

Three companies in the Netherlands and one in Italy are producing excellent bleached straw for the market. Two of the companies use the neutral sulfite process, one the sulfate process, and one the CELDECOR process. Samples of machine and air-dried pulps from each of these companies have reached Peoria, where they will be carefully investigated. The Netherlands Straw Experiment Station is also making an examination of the three Netherland pulps. It is planned to publish a joint report on these Netherland pulps by the Northern Laboratory and the Netherlands Straw Experiment Station.

From this extensive view and discussion of residue pulping processes, I am convinced that the newer pulping methods of the Northern Laboratory are far more suitable for the use of the American industry than those in commercial operation prior to this work. Because of the European and English viewpoint in papermaking and the technical background developed on this account, the great potentialities in the use of straw, bagasse,

and like residues have not been visualized. By developing processes involving mild chemical action to produce high-yield, free-draining, strong pulps, this goal is being realized.

The technology of pulp and papermaking in America has surpassed that of England and Europe, but since these countries are installing a few fast-running, modern paper machines, conditions in Europe will gradually change with competition.

On the other hand, American mills can learn a good deal from English and European mills on straw chopping and cleaning.

Of the research institutes visited, two each were in England and the Netherlands and one each in Belgium, France, and Italy. None of these is as well equipped and generally not as well staffed as the Regional Laboratories, the Forest Products Laboratory, the New York State College of Forestry, or the Institute of Paper Chemistry. On the other hand, these institutes were all engaged in a study of fundamental problems. While most were engaged also in studying some more practical industry problems, they seemed to be less industry-minded, comparatively, than the staffs of the American institutions above.

Companies and Institutions Visited

ITALY

FRANCE

BELGIUM

NETHERLANDS

ENGLAND

- - -

ITALY

I had hoped to be able to visit either the "Celdit" mill of Cellulose D'Italia at Chieti or the state-owned mill at Foggia while attending the FAO conference in Rome, but no time was available for this. Both of these mills utilize the Pomilio process of soda-chlorine pulping. However, Dr. Giulio Consiglio, a director of Sindacato Cellulosa Pomilio, was a member of my committee at the FAO conference and he arranged for me to visit other mills using this process, which will be discussed later in this report. The larger paper mills are located in northern Italy and I arranged to visit these in Milan and Turin.

December 15-17, 1952:

The Italian Association of Paper and Board Manufacturers, Corso Italia 8, Milan.

I called on Director, Dr. Marisa Donvito at the Milan headquarters of this Association. Dr. Donvito's daughter, who edits the magazine of this Association, speaks fluent English and acted as interpreter at the meeting. There are many paper mills in Italy, most of them small. About 25 percent are very small family mills making only a ton or a few tons of paper per day. Companies representing about 300 mills are members of the Association.

The paper industry was operating at only about 50 percent of capacity at the time of my visit. Production and trade in paper was also slow in the United States, France, Holland, and England. This was due in Europe to an over-inventory of high-priced imported imported pulp and a slackening demand while waiting for lower prices. About 120,000 metric tons of pulp were produced in Italy in 1952, of which about one-half was made from straw, mostly wheat, but some rice straw was used during the time rice was harvested. About 150,000 metric tons of wood pulp was imported, mostly from Sweden and Finland.

The production of straw in Italy is about 6 to 7 million metric tons, with which about 7 million metric tons of wheat is produced. Italy imports and will always import much wheat, so the possibility of increasing the production of straw does not seem to be bright.

The total consumption of paper is about 250,000 to 300,000 long tons. Straw was not used greatly for papermaking until Mussolini's self-sufficiency program was instituted. At the same time a program of growing hybrid poplar trees was started. All the mechanical pulp used in Italy for newsprint and other papers is produced from poplar. Many paper mills have small straw pulp mills integrated into their operations. When imported pulp costs are high, these pulp mills of 15 to 20 tons daily capacity are operated, but are shut down when imported bleached pulp is lower priced. During my visit, Swedish bleached pulp could be imported at a lower cost than bleached straw pulp could be made.

Miss Donvito said that bleached straw pulp is used as a blend with wood pulps in making a wide variety of papers but that the composition of the blends is a guarded secret with the various companies.

CEPLECOL, Via Podgora 3, Milan.

This company, which builds chemical plants and cellulose pulp plants, has been very much interested in the mechano-chemical process and in building equipment for use in the process. Dr. P. Rossignoli, president of this company, is a graduate of the Paper School at

Grenoble, France, and was instrumental in the development of the neutral sulfite process for pulping straw in Italy, being for some years managing director of Cartiera Italiana. Dr. Rossignoli now lives in Turin and he also is head of a large steel company that manufactures equipment for industry. Dr. G. Bertolini and Mr. Monti are chemical engineers associated with CEPLECOL. This company arranged appointments for me in Milan and supplied me with one of their employees, Mr. E. C. Merlini, as interpreter.

I discussed the work of the Laboratory on straw pulping with the CEPLECOL engineers. They said that they felt the mechano-chemical process is superior to the neutral sulfite process for pulping straw for any purpose. The operating details of this process were discussed, a flow sheet was drawn up, and samples of paper and board which I had with me were examined.

They said that most of the integrated mills now operate small straw pulping plants. They wondered if the advantages of the process would be sufficient to offset the present high cost of machinery in Italy. Recognizing that the process was especially adapted to the use of small plants, they thought there might be interest in central and southern Italy.

Cartiere di Verona, Via G. Serbelloni 4, Milan. Ing. C. Gregotti, Managing Director.

This is the largest company in Italy manufacturing paperboard, having a production of about 45,000 tons per year in three mills. The company manufactures many kinds of folding boxboard, test liners for corrugated boxes, and solid fiber boxes.

It also manufactures several grades of specialty papers, the most interesting of which was a corrugated strawboard paper used as a honeycomb core for veneer in making door panels and modernistic tables, chairs, and other furniture. Casein glue is used as the adhesive. One sample exhibited was a spiral veneer board made in this way. The material to be laminated is laid up, together with proper glue lines, and is covered with rubber sheeting. The composition is placed under vacuum during the time to complete the cure of the glue. Two sizes of corrugations are used: (1) An open cell of about 1/4" in depth and breadth, the honeycomb being overall about 1" thick; (2) for smaller installations, 1/8" corrugations and the honeycomb less thick is used. The panels made in this way are very light in weight and of excellent appearance. The company believes that there is a large volume use for this material.

Mr. Gregotti was very much interested in my discussion of the Northern Laboratory's work in connection with the American strawboard industry. He thought the samples of corrugating board produced by the mechano-chemical process were the highest quality in crush resistance he had

ever seen. He believes that straw is better suited to the manufacture of corrugating medium than pulpwood, because of the higher pentosan content.

Mr. Gregotti asked me if I would like to visit their straw mill. This mill has two 12-foot rotary digesters and produces about 20 tons of unbleached pulp per day using lime as cooking chemical. Since the mill was not operating and my time was limited, I declined the offer and talked to him about straw procurement.

Because of other uses and the differences in the amount grown from year to year, it was difficult to maintain any fixed price for straw with the farmer. An endeavor had been made to work out a cooperative arrangement with farmers but this had failed. The company procures and uses rice straw satisfactorily during the months of November and December when the rice is being harvested. The rice straw is wet at the time of harvest so that it cannot be stored in bales or in loose piles without rapid rotting.

<u>Experimental Station for Cellulose, Paper, Vegetable, and Artificial Textile Fibers (Statione Sperimentale per la Cellulose, Carta e Fibre Tessili Vegetali ed Artificiali)</u>, Piazzo Leonardo da Vinci 26, Milan.

Dr. Germano Centola, the director of the institute, was a member of my committee at the FAO conference and I had previously met him at the International Pulp Symposium at Appleton, Wisconsin, in September 1951. Dr. Fransesco Pancirolli is vice-director.

This institute is located on a part of the campus of the University of Milan and is a part of that university. In addition to government support, the institute also receives support from the textile and paper industries. The institute is the main research center for these industries and is one of the largest and best equipped institutes I visited. More attention is given to textile problems, because the textile industry in Italy has been more prosperous than the pulp and paper industries and has contributed larger sums to the support of the institute. I suggest that this institute be visited by Dr. Fisher during his contemplated European trip.

The institute has been and is carrying on research on poplar, softwood, and straw pulping.

I arrived at the institute about 4:00 p.m. and left about 8:00 p.m. and, therefore, did not have an opportunity to visit the four-story textile mill used as a pilot plant.

Dr. Centola, with Dr. Pancirolli, first discussed the purpose, organization, and work of the institute, and then conducted me through the various laboratories having special reference to pulp and paper.

Dr. Centola expects during the coming year to add substantially to their equipment and particularly to rebuilding the large pulping pilot plant referred to hereafter.

Fundamental studies are being conducted on high polymers, including cellulose. A General Electric X-ray machine is being used to determine amorphous and crystalline areas in high polymers. The molecular weight of vinyl acetate was being studied in a German ultracentrifuge modified in design according to Dr. H. Mark of Brooklyn Polytechnic Institute. Studies were under way to determine if ultrasonic waves would assist in more level dyeing of textiles. So far the results of this work are indeterminate.

A study is being made of the bleaching of cotton by ozone. Up to the present, the laboratory results have not been consistent. However, bleaching with ozone is being used by a cotton mill in Italy with excellent results. A high white cotton cloth is obtained and there is no tendency to reversion in color.

Two instruments, among many in the textile laboratory, were of interest to me. These were used for determining the uniformity of the denier of fibers. One made by Zellweger, S.A., Uster, Switzerland, depends on the measurement of capacitance and impedance. The variations in current as the thread passes through the machine are integrated and plotted continuously in the form of a curve. This instrument was said to give very accurate results. In the second machine, the thread passes continuously through a tube filled with mercury, the lower end of the tube being a fine capillary. The variations in the conductivity of the mercury column are measured by means of a wheatstone bridge and the galvanometer fluctuations are photographed. By synchronizing the speeds of the winding drum for the thread and the drum carrying the photographic film, the changes in the denier of the thread are registered and measured.

Two physical testing laboratories, controlled relative to temperature and humidity are installed. One is for testing textiles but contains some paper-testing machines, and the other--which is not quite completed--will be for paper testing only. Several machines, new to us and all made in Europe, are in use for testing various properties of paper. One, a machine called "Leverautör" made by A. B. Lorentzen and Wetters in Sweden, is for measuring the double-fold characteristics of paper. Five samples of paper can be tested on this machine at one time, compared with one sample on the Schopper-Riegler fold tester. By changing the weight on the sample, it is possible to increase or decrease the tension. The number of double folds for a specific sample varies with tension. With a 50-gram weight, the results are close to the Schopper-Riegler fold tester. Dr. Centola says most of their tests are made with the Schopper-Riegler fold tester because of its wide use in industry and the large background of test data available. A wide variety of tensile testing machines are available for use with textiles and paper.

The pulp-testing laboratory is large, and is very well laid out and equipped. Sheet machines for preparing pulp sample sheets of both German and Swedish make are in use. I saw one or the other and frequently both of these machines in use in the other laboratories I visited on this trip, excepting, of course, in England where they use the British sheet machine as we do in Canada and the States. These European machines make a somewhat larger sheet than ours, they appear to be easy and rapid to operate, and were said to be capable of yielding replicable results.

The institute has two Valley beaters of Swedish make, which did not seem to be in good shape and were said not to be greatly used. The Jocro mill is preferred for pulp-strength development. The mill is also widely used in Western Europe and particularly in Germany. This mill consists of a hollow oval bronze cylinder, the inside surface of which is grooved in a regular fashion. An oval bronze solid chase, a little smaller than the inside diameter of the casing, is grooved in the same pattern as the inside of the casing so that the grooves cooperate as in a gear box. Sixteen grams of pulp at 6-percent consistency are placed in the cylinder, the lid is closed, and the cylinder is placed in a large laboratory centrifuge rotated at a uniform speed. The chase is caused to roll around in the casing of the mill, pressing the pulp under centrifugal force between the grooves of the casing and the chase. Five mills can be operated at one time. Good replicate results can be secured. The results are not believed to bear any direct relation to the results from refining the same pulp in a commercial paper mill. The method is liked because good check results can be secured and because not only is the method rapid but only small samples of pulp are required.

A variety of small laboratory autoclaves are available, none of which can be discharged by blowing, and none are as large or as versatile as the stainless-steel twin autoclaves at Peoria. Some small pressure vessels are in use. These are placed in a larger digester and are each capable of preparing about 250 grams of pulp. In this way several pulping variables other than time and temperature can be explored at one time.

Dr. Centola had become interested in our mechano-chemical process. He installed a pilot-plant model of the Jones "Pulp-Master" which is about the same size as the Peoria 3-foot Hydrapulper. He has been experimenting with pulping straw and bagasse. He was disappointed with results and, fortunately, was able to show me samples of straw pulp produced in an experiment of that week. The amounts of chemical used were as we had directed but the straw was not satisfactorily pulped. I showed that the impact force of this machine was not vigorous enough to carry out the process. I suggested, if possible, that he install a larger motor and triple the speed of the rotor. Since the rotor is of a radically different design than that of the Hydrapulper, I was uncertain whether they could use the small machine satisfactorily. We had used a 1-ton Jones Pulp-Master to pulp straw sometime ago but this machine did not work as well as some other pulpers. Both Drs. Centola and Pancirolli were greatly interested, and I believe understood my discussion. More recently, a letter from Dr. Centola inquires where he can obtain a Hydrapulper similar to that in the Peoria Laboratory.

In addition to the equipment described, Dr. Centola showed me a large pilot plant for pulp preparation which they expect to modernize. This plant has not been used for some years. It contains two spherical, rotary, pressure-digesters of about 1,000 liters' capacity, one built for use with alkaline pulping chemicals and the other for use with acid chemicals. Two tile-lined beaters of about 500 pounds' capacity, one which is supplied with a washing drum and is used for bleaching, seem to be in fair shape. A wet machine, in bad repair, and a Kollergang complete the layout.

Both Drs. Centola and Pancirolli were extremely cordial and answered all my questions. Since my return I have seen a report on a new process proposed by this institute for pulping straw, using lime and sulfur. So far as we know, this process was used years ago in Illinois and has been discarded.

<u>Cartiere Fagioli</u>, Piazza Fiume, Milan. Mr. Paride Fagioli, President and General Manager.

This is a small company manufacturing cartons and boxes from waste paper and imported pulp. Dr. Joseph Atchison of Mutual Security Agency had said that this company might be interested in building a straw mill and it seemed desirable to learn their viewpoint.

Mr. Fagioli is a very alert young man who has visited the United States, Brazil, and African paper industries. He purchases Swedish and Finnish pulp. He showed a proposal from Black-Clawson International for the installation of a pulping and refining system. He had not gone further in the development of a straw-pulping plant than when Dr. Atchison had seen him. He became very much interested in my discussion of straw pulp for corrugating medium and liner board and in the samples prepared from mechano-chemical pulp. He had in mind a 10-ton pulp mill for straw and wanted a proposal for the mechano-chemical process. I told him that CEPLECOL had some interest in supplying pulping equipment and that he could obtain detailed information from them. I was later told that he perhaps was interested in a 20-ton plant.

<u>Cartiere Prealpine</u>, Via Victor Hugo 2, Milan. Dr. Ing. Corrado Nodari.

I arranged to see Dr. Nodari because we had learned through correspondence with him of his interest in building a mill to pulp straw by the mechano-chemical process.

This company operates two mills, one a bond paper mill using imported softwood sulfite and specially prepared Italian poplar pulp. Its main business is, however, the manufacture of vulcanized fiber and bakelite-type plastics from resin-impregnated 100-percent rag bond paper. This paper, together with the chemicals, is made in another mill. Dr. Nodari is a young man as is also Mr. Vazzoli, the manager of the company. The company, however, is old. Dr. Nodari has visited the United States and

more recently in Mexico. One of his friends in Mexico is installing a mill to pulp depithed bagasse by the mechano-chemical process. Dr. Nodari is very much interested in this process and arranged to have about 20 tons of depithed, mechano-chemical bagasse pulp shipped to his mill, where the pulp was bleached and was made into a variety of fine papers, most of the papers being blends of bagasse pulp with wood pulp but some of the papers being made from 100-percent bleached bagasse pulp. Dr. Nodari gave me a notebook made of ruled 100-percent bagasse paper and a book of samples of a variety of grades and weights of papers made either wholly or partly from bleached bagasse pulp. The papers are all of good quality. Dr. Nodari showed me a large poster printed in five different colored inks. He stated that perfect register of the printing was obtained with this 100-percent bagasse paper and that in their experience this was the best sheet for five-color printing in his experience. I told him that the same results should be obtained from straw pulp made by the mechano-chemical process.

He had arranged for Dr. Centola at the Milan Institute to try the mechano-chemical process in the 3-foot pilot-plant Jones Pulp-Master, but results had been disappointing. I explained the cause for this. He has since written that, together with Dr. Centola, he plans to visit the "Union Mill" in Holland where the mechano-chemical process is being used to pulp straw.

<u>Cartiere Vita Mayer and Company</u>, Via Monte Napoleone 9, Milan. Dr. E. Kruger, Director of Research, Dr. Pietro Ghirsoni, Technical Manager of Pulp and Paper Mill.

Dr. E. Kruger, one of the members of the FAO conference, invited me to visit the Vita Mayer research laboratory and paper mill when in Milan.

This company was started in 1907 by Mr. Mayer with a production of 50 tons per year. He had the idea of increasing the production five times each year. The company today has a production capacity of between 150 to 200 tons of paper per day, about 50,000 tons per year, and expects within 1 year to reach a production of 60,000 tons. The company now produces 40 percent of the kraft paper made in Italy. Their paper is sold in Italy, Yugoslavia, and Switzerland. The latter country has 5 paper mills of its own.

To indicate the progressive attitude of the company, its mill, located in a small village about 20 miles from Milan, has a permanent employment of 800 people. The company is building good duplex houses in this village for its employees, which may be bought without any down payment, and by a small deduction each pay day from the employees; they pay for the house in 20 years. The school system in Italy is poor. The schools are free only through the grammar grades which the child finishes in about 10 years, but children are not allowed to work until 15 years of age. The high schools on the average are not good and are quite expensive. Five years ago the company began the employment of about

50 boys each year by putting them into a company-supported school in which, in addition to regular high school subjects, courses in pulp and paper manufacture are taught. Those that pass their examinations, about 20 out of 50, receive permanent employment by the company. These are bright boys. During my visit at the plant, the operators all seemed to be alert and interested in their duties.

Dr. Kruger is trained as a physicist and spent a year in post-doctorate work at California Institute of Technology in Los Angeles. On return to Italy he became a consultant to Vita Mayer in building and equipping a new research laboratory: An offer to teach in the University of Buenos Aires, Argentina, caused his employment by this company as research director.

Dr. Ghirsoni has been with the company for 16 years. After obtaining a degree in chemistry from the University of Milan, he took charge of the company's laboratory and became progressively chief of the pulp mill, chief of the paper mill, and now chief of the whole operation. Dr. Ghirsoni has traveled in the United States and is well known to members of the American industry.

First, I visited the new research laboratory located on the outskirts of Milan. Milan looks more like an American city than any I saw. It suffered considerable bombing damage and numerous skyscrapers (20 stories) have been or are being built. People in Milan seem more in a hurry than in other Western European cities. The laboratory is a new three-story building, in general, of modern construction with marble stairways, corridors, and wainscoating. The offices and laboratories are large. Many of the laboratories are not yet equipped. The research laboratory is now staffed with 7 college men and about 20 assistants. Dr. Kruger expects eventually to employ about three times this number. According to American standards, this is an expensive building and a large staff for the paper production involved.

Dr. Lombardo is in charge of cellulose research and pulping. Their large humidity room is controlled according to Technical Association of Pulp and Paper Industry specifications and TAPPI methods are used for pulp and paper analysis and testing. A very complete set of testing instruments is installed. Two good modifications of the British sheet-making machine have been worked out. A cast-aluminum holder has been developed for the polished steel plate and adhering test sheet during air drying. The holder is provided with quick-opening screws and one of the screws fits into a movable hook attached to a 1/8" pipe rod so that a large number of the holders may be attached to the rod. Good air circulation is maintained over the test sheets and table space is freed.

When using the standard British press in pressing test sheets it was found that a certain amount of water is trapped and is taken up by

the sheet when pressure is released. The sheets are now pressed in two stages, the first being by a hand press so that free water is expressed and drained off, after which the sample is pressed in the regular British press.

The Valley beater is used for pulp development and this is standardized against purchased Swedish kraft pulp.

Their digester is old-fashioned and not suited for blowing pulp. A new one is planned. An adequate pilot plant for small-scale pulping, screening, etc., and a good shop for building machines and instruments are in use.

The staff is conducting some fundamental studies. They have an electron microscope and are equipping a dark room for moving pictures. By use of a camera which can take 3,000 exposures per second, they hope to be able to study paper formation on the paper machine wire. They have a start on a good library and are purchasing many journals and texts.

Dr. Kruger is interested in preparing pulps by different methods and blending these to produce specialty papers, for example, cooking the same wood by the kraft process to: (1) Produce a hard pulp, and (2) produce an easy-beating pulp which would be highly hydrated. The rather lightly refined pulp would be blended with the highly hydrated pulp. This is, of course, much like the idea that Dr. Aronovsky and I have had in the use of agricultural residue pulps with wood pulps, where the agricultural residue pulp would be highly hydrated and the wood pulp would be lightly refined. I suggested that poplar, or straw, as better, might be pulped to produce the highly refined pulp since the hemicellulose content of the pulps contribute to high hydration at low power consumption. For this reason the mechano-chemical process--which results in especially high pentosan-containing pulp from straw--was recommended. This suggestion was evidently of great interest to Drs. Kruger and Lombardo, who said that they would investigate the subject fully.

From the laboratory we drove to the pulp and paper mill which consists, like most European mills, of brick buildings. Considerable modernizing and alterations were under way. Seven paper machines are installed, the last one being quite modern. The wet end of this machine was built in the shops of Vita Mayer. The dryers on this machine are heated by water under pressure, by a process developed in Switzerland by Treversan. The water enters the drying cylinders at 155° C. and leaves at 135° C., passing through a heat exchanger to be recycled. This avoids all difficulty in temperature control in dryers due to condensation water. This system is liked very much, but it is said to have high operating costs.

The papers made are cement and other types of bag, including striped shopping bags, wrapping papers, bleached fruit-wrap tissue, and some

toilet paper, the latter all MG finish. The kraft pulp is bleached in a five-stage system to a brightness of 82. It is very clean and is of as fine quality as I have ever seen.

Pulp is produced mainly from softwood by the kraft process, but some mechanical pulp is made by grinding hybrid poplar. Ninety percent of the softwood is waste wood, mostly spruce, and is obtained from wood-working plants in southern Italy near Florence and farther south. The wood is in the form of slabs and poles, and is dry and free from bark. The wood in railroad cars from southern Italy being unloaded during my visit costs about $8 plus $4 freight per short ton, delivered. Some difficulty is experienced in chipping some of the wood. Sixty-inch chippers are used. The chips pass through a large rotary screen, the oversized being reduced by passage through a hammer mill. Most of the wood is cooked in pressure digesters by the conventional kraft (sulfate) process. In March 1952, a continuous Kamyr (Swedish) kraft pulping process was installed. A special arrangement has been made with Kamyr to the effect that the plant is experimental, so that Vita Mayer is not paying a royalty. Since this new type of continuous pulping process will be mentioned in connection with two other visits, it seems desirable to give a general description of the process, of which I later received a flow sheet from Papeteries de France.

The chips are fed by means of a barrel valve into an impregnating chamber consisting of a steam-jacketed, horizontal cylinder fitted with an internal helical screw. The purpose of this and the second chamber is to wet and soften the chips. From this chamber the chips are fed through another barrel valve into a similar chamber. Hot black liquor fortified with fresh chemical is fed with the chips into the first cylinder and the chips are gradually heated to 120° C. through the two impregnating chambers. From the second chamber, the hot wet chips are fed through another barrel valve to the top of the digester tower proper, working down through this 75-foot digester tower by gravity. Two cooking zones are maintained in the digester by recirculating cooking liquor through separate heat exchangers. The top zone temperature is maintained at 150° C. and here the chips, at a consistency of 10 percent, are fully impregnated with cooking chemical. The second zone is maintained at a temperature of 175° C. and here the chips are pulped. At the bottom of the pulping zone a scraper is provided which keeps the pulp from packing at the sides and bottom of the digester. At this point, most of the chips are in the form of pulp. To remove the pulp from the digester, hot black liquor is pumped in at the bottom to lower the consistency of the pulp so that it can be pumped to a separator provided with screens. The excess black liquor drained from the pulp is pumped back into the bottom of the digester. The pulp, still under a pressure of more than 100 p.s.i., is injected into a blow tank by the alternate opening and closing of two Asplin valves. The pulp is then diluted and pumped to a three-stage Oliver vacuum washing system and leaves at about 12 percent consistency, with no alkaline taste. The pulp is of a grey rather than the reddish color of

American kraft pulp. The pulp is composed of very long fibers and is claimed to be very strong and to compare favorably with the best Finnish kraft.

From March until May this system, at the suggestion of the Kamyr engineers, underwent many changes. Since that time the digester has been on stream most of the time. Residence time in the digester is 2-1/2 hours, but it is believed that this time can be reduced with better operation to 2 hours and that with the shorter cooking cycle the quality of the pulp will improve. It is planned to refine the partially disintegrated chips just after they come from the digester, while still under pressure, by passage through a homemade jordan-type refiner. This will break up all the chips and open up the pulp for easier and better washing.

Trouble has been experienced with packing for valves, bearings, etc., and an entirely satisfactory material is still being sought. When the plant is shut down for any cause or over the weekend, trouble has been experienced with bridging of chips near the top of the digester tower. This can be cleaned by repeated pumping of liquor. However, it seems to be the best practice not to empty the tower. The Kamyr system uses only about 60 percent of the steam required for the conventional batch process and eliminates about one-half the labor.

The black liquor is recovered in a newly installed Tomlinson furnace made by Babcock and Wilcox Company. One of the most modern installations, it is provided with an automatic blower and a patented Swedish device for circulating shot through the flue ducts to loosen scale and soot. An electrical precipitator is installed to collect dust. Since the pulp mill is located in a small valley, some nuisance has resulted because of kraft odors. To overcome this, the recovery furnace stack of more than ordinary height has been built on top of the highest hill, and the hot gases are led up the side of the hill to the base of the stack by a long conduit.

The Tomlinson furnace produces 20 metric tons of steam per hour or 11,000 pounds of steam per ton of wood pulped. The black liquor is evaporated to 58 percent solids in a quadruple effect followed by a high-speed evaporator. The recovery system produces sufficient steam so that the full requirements of the pulp mills and paper mill are satisfied. The steam developed at 600 p.s.i. is reduced through turbines producing 1,000 kw.-hrs. per ton of wood pulped. The cost of the Kamyr kraft pulp, including wood, chemicals, steam, labor, but not overhead, is $90 per metric ton.

Dr. Ghirsoni drove me back to Milan and during the lunch hour I continued the discussions with him and Dr. Kruger. I had mentioned in the paper mill that the chemical pulps were so strong that costs might well be reduced by blending in mechanical or hardwood pulps. Dr. Ghirsoni said that they were considering pulping hardwoods and

asked my opinion regarding hardwoods vs. straw pulps. This led to a discussion of the Northern Laboratory work and I recommended straw, providing the mechano-chemical process was used. Dr. Kruger asked for reprints of our work for his library.

December 18, 1952:

Cartiere Burgo, Via Cassini 19, Turin.

Dr. Rossignoli met me in Turin. He endeavored to obtain permission for us to visit the neutral sulfite straw mill of Cartiere Italiana of which he had been formerly general manager but this was refused. However he arranged a conference with Dr. Ing. Piero Bersano, technical director of Cartiere Burgo. Dr. Bersano is a member of TAPPI; he speaks excellent English, has traveled in the United States, and is familiar with our work on straw. He was extremely cordial and answered all my questions and said he would be glad to answer further questions by mail.

Cartiere Burgo is the largest paper mill group in Italy, operating 11 mills. The mills in this group were improved and consolidated during Mussolini's self-sufficiency program. The straw mill at Ferrari was built by Marshal Bilbo. After the war a very progressive group of young engineers and businessmen have come into the management of this company.

Dr. Bersano stated that they had been experimenting with straw pulping since 1932 but had not started into actual operation until 1942. I did not have sufficient time to visit the straw pulp mill at Ferrari. This mill uses the neutral sulfite pulping process, 10 percent neutral sulfite, 5 percent NaOH, basis straw, and cooks for 8 hours at 160° C. They obtain an unscreened yield of 56 percent and a bleached yield of 42 percent based on one-stage bleaching with calcium hypochlorite.

After reviewing the Northern Laboratory work on the neutral sulfite process in which sodium carbonate instead of sodium hydroxide is used, they have changed to our conditions, raising the temperature to 170° C. and cooking for about 2 to 2-1/2 hours. They have also installed a three-stage bleaching system and are now able to produce a cleaner, white pulp. They state that the use of our system has proved more economical.

Dr. Bersano said that straw near Ferrari is of good quality and is costing about $15 per ton. Further south in Italy the straw is not of such good quality. A few years ago Cartiere Burgo shipped a bale of Italian straw from near Ferrari to the Northern Laboratory, which analyzed and pulped like Illinois straw.

At the Ferrari mill a continuous Kamyr pulping process similar to that at Vita Mayer has been installed on an experimental no-royalty basis to pulp straw. This plant is designed to have a capacity of 25 tons per day and has produced 18 tons. The pulper, as designed for pulpwood use, is more complicated than is required to pulp straw. The chief

difficulty in operation has been feeding the straw. The chopped (Grumbach chopper), cleaned straw is wetted with chemicals (sodium sulfite and sodium carbonate), in a helical screw feeder, passed into the boot of an elevator, and fed into the first softening chamber through the barrel valve, from thence through a second softening chamber, and then through a barrel valve into the digester itself (75 feet high). The exit sides of the barrel valves are under higher pressure (steam) than the entrance sides and the straw does not make a good seal. Consequently, steam blows through the valves and blows the straw away from the entrance. This has been remedied by an arrangement using a double valve to reduce the pressure before steam has a chance to blow by.

Only one softening chamber is needed with straw and no impregnating zone is required in the digester, e.g., only one zone for cooking, and, hence, only one system to circulate liquor within the digester. The straw pulp is easier than wood pulp to remove from the bottom of the digester since it is completely defibered. The chamber to drain black liquor from the pulp leaving the digester is not needed and the pulp can be blown directly to the blow tanks through the two-way Asplin valve. Burgo is working to develop a nozzle through which pulp can be blown continuously directly from the digester. Dr. Bersano thinks that with the modifications indicated the capital investment cost of the digester per ton of pulp will be very low.

He is quite enthusiastic about the process. The pulp is being cooked with sodium sulfite and soda ash at 150° C. for 1-1/2 hours as compared with a temperature of 170° C. and 2 to 2-1/2 hours for the batch process. He claims that the pulp by the Kamyr process is stronger and more uniform. Dr. Bersano has sent us about 5 pounds of this bleached straw pulp in wet form. He also sent a box of bond stationery paper made from 90 percent straw pulp.

About five years ago, Burgo made a trial of the Hydrapulper for refining their pulp but preferred the Sprout-Waldron refiner because of higher capacity. They have not experimented with the mechano-chemical process.

Dr. Bersano has the same viewpoint as we have at Peoria, e.g., straw pulp finds its best use as a blend with other pulps in making papers. He stated that 10 to 15 percent of straw pulp is added with kraft wood pulp to produce stronger papers. He exhibited newspapers made from 60 percent poplar groundwood and 40 percent straw, and from 40 percent bleached poplar chemical pulp, 10 percent Swedish sulfite, and 50 percent poplar groundwood. Both of these newspapers were hard and brittle.

We then drove across Turin to their research laboratory, which is located in an old building. No special apparatus was displayed, such as was seen at Vita Mayer. This laboratory carries on the research for all the mills, although each mill maintains a control department.

The laboratory contains a large testing room controlled at 65 R.H. and 75° F. which is very well equipped with testing instruments, and which with a few exceptions were either of German or Swedish make. They have a G.E. brightness tester which they lease from the Institute of Paper Chemistry at Appleton, Wisconsin, through some special deal.

The Lampen mill (a bronze globe containing one large bronze ball) is used for developing pulp strength, largely because the company purchases Swedish pulp. It has been discovered that by reducing the rotation of the mill from 360 r.p.m. to 200 r.p.m. beaten straw pulps of higher strength are obtained. It is believed that at the higher r.p.m. the ball tends to slide over the "wet" straw pulp, while at the lower r.p.m. more time is given to pressing the individual fibers between the ball and the shell.

The digester room is very old, and the digesters are small, of very old design, and none can be blown. On a homemade paper coating pilot-plant machine experiments are being conducted for coating paper with casein or hot melt resins.

I left Turin early in the afternoon for Grenoble, France.

FRANCE

December 19, 1952:

Université de Grenoble, Institut Polytechnique, Ecole Francaise de Papeterie, Avenue Felix-Viallet 44, Grenoble.

The University of Grenoble was established in 1339, the Polytechnic Institute in 1903, and the French School of Paper in 1907. Among the distinguished names associated with the University are Champollion, who as a young man found the key to the translation of the hieroglyphics on the Rosetta Stone, which I saw later in the British Museum in London; Fourier, the mathematician; and Raoult, the chemist. The French Paper School is administered by three groups: le Ministere du Commerce l'Union des Fabricants de Papiers et Cartons de France, and l'Université de Grenoble, and is incorporated as Société Anonyme de l'Ecole Francaise de Papeterie. It, therefore, has both the support of the French government and the French paper and board industry. The Polytechnic Institute, in addition to the Paper School, has departments of Electrochemistry, Metallurgy, and Hydraulics.

Professor Felix Eselangon, director of the Polytechnic Institute, was absent during my visit and I was received by Professor M. Chene, director of studies and research and professor of chemistry of the science faculty, and Professor Marcel Aribert, technical director of the Paper School.

In addition, I met Professor P. Nobecourt, director of microscopy, and his assistant, Mr. J. O. Chiaverina, Professor Ph. Traynard, secretary of the faculty, Professor H. Bouchayer, chief engineer and assistant technical director, and Professor A. Ruby, librarian, together with two of the graduate students who acted as interpreters, André Eymery, E.F.P., and Abdul-Medjid Ayroud, E.F.P. and Ing. I.C.L.

This school, which has an excellent reputation in Europe, serves mainly for the purpose of training students for the pulp and paper industry. A four-year course is given, the first two years are devoted to general courses and the last two years to subjects more closely connected with the pulp and paper industry. No previous university training is required, but a state examination must be passed for entrance. A degree of E.F.P. is granted.

The laboratory and classroom facilities are extensive and ample for teaching the various analytical and physical testing methods used in the industry. Three paper machines are located at the school. The first, a museum piece, is the first paper machine, invented and built by Robert. This was the first mechanical paper machine and it preceded the invention of the Fourdrinier machine. For student use there is a complete paper machine with beaters, screens, and calender stack. This machine, which was built and installed in 1907, makes a paper sheet 1 meter wide and is used to teach the students the operations of papermaking. To pass their course, students must be able to operate the machine. In addition, a small machine capable of making a sheet 4" wide is available.

The sheet-making apparatuses in the laboratories are of German and Swedish standard makes. For pulp-strength development both the Lampen and Jocro mills are used, the Lampen being preferred. I mentioned the observation of the effect of r.p.m. on beating straw pulp in the Lampen mill to this group and to others in Europe, but no observations similar to those in Turin have been made.

Paper samples and handsheets are tested in a large laboratory maintained at 65° R.H. and 20° C. This laboratory had, I believe, the largest assortment of paper-testing instruments of any I saw. One of the research problems is the subject of instrumentation. I was shown a wide variety of instruments, many new to me. Time was not available to discuss these. Several new instruments for testing folding endurance, similar to those seen at the Milan Institute, were under test.

The school is particularly well equipped for microscopic studies, including a good dark room and photomicrographic equipment. They do not have an electron microscope but are working with a phase microscope, No. 1817 by WILD-HEERBRUGG Switzerland. This microscope gives a much clearer detailed image of fibers than the regular microscope. They prefer this instrument to the phase microscope made by Spencer in the United States.

The institute occupies four floors and in addition to classrooms and laboratories has research laboratories. Research work is largely carried on by staff members although there appeared to be a few graduate students. Laboratory desk tops here and in the Italian laboratories are made of white tile. These are not very satisfactory because they crack and break and also because the cement used is not resistant to chemicals spilled. Other parts of laboratory furniture are of wood.

The facilities for pulping were limited to the usual small European digester with no provision for blowing pulp or for outside circulation of liquor. Some work was being conducted on bleached straw pulp. Since my return I have been in correspondence with Professor Aribert concerning a problem associated with wheat straw of high pith content.

Research work is being carried on in microbiology, particularly in relation to slime problems in the paper mill and the mildewing of pulp. Another group is studying the problem of paper sizing.

Mr. Ayroud has been working with Professor Traynard on a lignin research problem, one of their researches being published in Bul. Soc. Chim. de France, p. 1101 (1952). In a study of the action of dry chlorine in carbon tetrachloride on dry poplar wood, the curve for absorption of chlorine showed three peaks. Photomicrographs show that each of these peaks is related to extraction of lignin in three different locations in the fiber walls. In the first step, lignin is removed from the middle lamella, in the next the removal is between the middle lamella and the outside portion of the fiber, and in the third stage removal is between the middle lamella and the inside portion of the fiber next to the lumen. If these findings are correct, it may explain the difficulty in removing the last of the lignin in bleaching pulp and why bleaching is best conducted in several stages.

Considerable time was devoted to a discussion of pulping straw. The work of the Northern Laboratory and the reasons why bleached straw pulps have been heretofore considered slow and undesirable for certain types of paper manufacture were described, e.g., retention of the fine fibers from the nodes, heads, and pith of the straw, and overcooking of high hemicellulose pulps with consequent chemical swelling or hydration. The new pulping procedures developed by the Northern Laboratory avoid these difficulties.

This subject was discussed with every group visited on the trip and always aroused the greatest interest.

Professor Aribert said that a small company, Soc. Anon. Glucol located near Sorgo, France, was manufacturing furfural from cornstalks and Arundo donax. The operation is on a very small scale

because of limited finances. At Professor Aribert's request I discussed this subject with him and promised to send the more important literature references on furfural manufacture.

December 20-27, 1952:

Societe des Cartonneries de la Rochette, 31 Rue de Constantine, Paris.

This is the largest group of paper mills in France and is controlled by Mr. Georges Franck and his cousin, Marcel. Mr. Franck had visited Peoria but had advised me he did not expect to be in Paris Christmas week. He very kindly arranged to see me the evening I arrived in Paris.

Mr. Franck is chiefly interested in the use of wood and waste paper. His company, however, owns and operates the new mill in Algeria, built to use the Cellulose Development Corporation (CELDECOR) process (Pomilio) to pulp straw and esparto. When he visited Peoria, Mr. Franck stated that the yields of pulp in that mill were about 38 to 40 percent whereas it was advertised that the yields were about 45 percent. Mr. Franck said during his visit that now and then under the best conditions a yield of about 45 percent was obtained. When I asked Mr. Franck in Paris if with their more extended experience in the Algeria mill he would build another CELDECOR plant, he said he would not, because of low yield, of the quality of pulp, which tended to be weak, and of high costs. He is considering the expansion of bleached straw production and favors the use of the conventional pressure kraft process. When asked my opinion, I suggested the mechano-chemical process which he had seen demonstrated in Peoria, but he said he thought chlorine requirements were high. He mentioned the continuous Kamyr process used by Cartiere Burgo and I believe that he has this process in mind.

Mr. Franck has established an engineering organization, Centre d'Etudes et de Recherches pour l'Industrie de la Cellulose, C.E.R.I.C., in Paris, of which Dr. Jacques Michon is head. This organization not only carries on engineering work for Cartonneries de la Rochette, but also acts in a consulting capacity to other companies. Dr. Michon was a member of my FAO Committee and also was the first manager of the Algerian CELDECOR mill. He is very cool to the CELDECOR process. Dr. Michon just before coming to Rome had spent some time in South America studying possibilities of building mills for pulping agricultural residues and tropical hardwoods.

Mr. Franck is also arranging to set up a central laboratory research department in his company. Professor René Lapeze of the Paper School of Grenoble, who also visited Peoria, has been chosen to organize and direct this laboratory. Mr. Franck discussed the organization and function of this laboratory with me. His idea is to place the laboratory at their mill at La Rochette, near Grenoble, so as to take advantage of utilities, lower rents, and living costs. I warned him

of the danger of such a move and said that unless the laboratory is set up quite independently of the operating mill it would soon find that all its time would be taken in solving small production problems. I missed seeing Professor Lapeze in Grenoble but saw him for a short time in Paris. He is insistent that the laboratory be placed in Paris.

<u>Gaillet and Hartig (France)</u>, 7 Rue de Naples, Paris, Mr. Michel Sirvin.

This company is the representative of the Black-Clawson Company in France and Belgium, and because they act as sales agents of the Hydrapulper they have been interested in promoting the use of the mechano-chemical process. Mr. Sirvin, although a Parisian, spent three years at the New York State College of Forestry at Syracuse and, consequently, speaks good English. He had only recently returned to France. This company extended the privilege of addressing my Paris mail to their office. Mr. Sirvin not only arranged conferences for me but in most cases accompanied me, often using his automobile. This gave me an opportunity to discuss with him the problems of straw pulping and the French paper industry at some length.

<u>Cellulose de la Seine</u>, 161 Avenue de la Republique, Nanterre (Seine). Mr. René Avot, General Manager, Mr. R. P. Mousselin, Chemical Engineer, Mr. Roulier, Engineer.

This mill, one of the largest pulp and paper mills in France, is located on the outskirts of Paris on the Seine River. The mill is modern, being built in 1939, has four 170" trim and one smaller specialty paper machines, and the rated capacity of the mill is 400 metric tons per day. Facilities for handling about 130 tons waste paper per day and for producing 150 metric tons of mechanical pulp are provided. Newsprint, bag, and other papers are manufactured. In order to become more self-sufficient, a pulp mill to produce straw pulp has been built. This pulp mill uses the CELDECOR tower to digest the straw to produce a semipulp, and a five-stage Kamyr bleach system to convert the digested pulp into bleached straw pulp having a brightness of about 80-82. The present CELDECOR tower has a capacity to cook 75-80 metric tons per day, producing about 25-30 tons bleached straw pulp per day. A second tower had just been installed, but was not yet in operation, and the capacity of the bleach plant was expected to be doubled.

Straw costs about $12 per ton delivered in wire-bound bales, weighing about 110 pounds each. The straw is stored in warehouses both on the farm and at the mill. In all Western Europe I saw only one mill where straw was stored in the open. The straw was threshed with the chaff separated and was free from weeds, as was also the straw I saw in Holland. Some difficulty has been experienced in procuring straw since the farmers consider the price too low. The variety of straw procured is a solid stem type, that is, the stem is filled with pith. The difficulty in using this straw is described on the next page.

The baling wires are removed by hand as the bale is placed on a conveyor at about floor level. This permits the bale to open up along the planes of layers of straw in the bale. The material is fed into a Grumbach chopper (German make with rotary blades). The knives are sharpened every 8 hours. The chopper has a capacity of about 100 tons per day. The chopped straw, about 3-4" long, passes through a rotary screen and the dust removed is collected in a cyclone. No use has been found for the dust and it is burned. I suggested it be mixed with ammonium sulfate and sold as a fertilizer. The cleaned straw is blown into the digester building. For the use of the expanded straw mill, a Robert Nyblad straw chopper made in Payenburg, Germany, has been purchased. This chopper is of the lawn-mower type, has somewhat higher capacity, is more rugged, and uses slightly more power than the Grumbach chopper. Both choppers use about 40 hp. motors.

The chopped straw from the conveyor at the top of the digester building falls into an open trough mixer about 15 feet long and 2-1/2 to 3 feet high provided with a helical screw. The straw is mixed with hot caustic soda of about 3.5 percent concentration. The conveyor forcibly immerses the straw, but the straw is immersed only a short time. The straw is conveyed into the top of the CELDECOR digestion tower which is about 75 feet high and 5 feet in diameter. Twenty feet from the bottom of the tower the diameter is increased to 10 feet, a scraper stirrer is placed in the bottom of the tower, and provision is made for injecting water into the bottom of the tower. These provisions are for lowering the consistency of the pulp so that it can be removed from the tower by pumping. The tower is jacketed intermittently for steam heating along its length, down to the point where it is expanded in diameter. The straw at the top of the tower is under atmospheric pressure and at the bottom is under the pressure of the 55-foot column of straw, the temperature a few feet down in the tower approaches 100° C., and at the bottom of the jacketed section varies between 110° to 125° C. depending on operating conditions. The ratio of liquids to solids is about 3 to 1, from 12 percent to 13 percent NaOH is used on the basis of air-dry straw, and the straw is in the tower about 1-1/2 hours. Live steam is also used in the bottom of the tower to assist in removing the straw which is pumped out at 4.5 to 5 percent consistency.

The rest of the system is not the standard CELDECOR chlorine tower and bleach plant, but is a five-stage Kamyr bleaching system. The pulp from the digester is washed over a vacuum washer and is pumped at 6 percent consistency to a Kamyr tower where 75 to 80 percent of the total Cl_2 bleach requirement is satisfied by injecting wet Cl_2 gas. From this first stage the pulp is passed over a vacuum filter where it is washed with hot water. It is then treated with 2 percent caustic soda at 8 percent consistency and passed into a diffuser tower where it is diluted to 2 to 3 percent consistency and recirculated with a pump for good mixing. The pulp is then screened to remove nodes and other screenings. These rejects are passed through a Bauer refiner and the ground-up material is sold to a board mill.

The screenings and rejects consist largely of nodes or broken nodes, some apparently good fiber, and many pieces of uncooked straw. It is evident that the pulping action is not uniform in the CELDECOR continuous digester. This will be discussed more thoroughly in connection with the SOVE plant in the Netherlands. A yield of 50 percent is obtained from the digester and the yield of bleached pulp is 40 percent. The pulp from the digester contains about 10 percent rejects and another 10 percent is lost in bleaching. The bleached straw pulp has a good appearance, it seems to be clean, but is quite slow draining with a freeness of 56 S.-R.

After screening, the pulp is riffled and then is bleached with 2 to 3 percent hypochlorite in a diffusion tower where it is recirculated by pumping. It is then washed over a vacuum washer and is ready for use directly in the mill. Chlorine usage is claimed to be 12 percent.

Excessive foaming on washers and throughout their bleaching operations is the problem with the pith-containing straw. Foaming is said to be greater with fresh straw than with straw stored for six months or so. A solution for this problem had not been found. A suitable machine for defibering the pulp from the digester so that washing would be improved was being sought. A German refiner of a disc-mill type was not satisfactory.

I analyzed the foaming problem by pointing out that the straw in the mixing machine before the digester was not immersed in hot caustic long enough to drive all the air from the pith. Furthermore, the liquid-to-solids ratio in the digester was so low that the air was not removed from the pith cells in this operation. Consequently, when the pulp was diluted in the chest, pumped, washed, bleached, etc., the air entrained in the pith was continuously released, and into liquid suspensions of low surface tension. The answer to the problem was to eliminate the air from the pith cells before the washing and bleach systems. I described a process development made at Peoria which would solve the foaming problem and carry out the defibering; namely, pump the stock coming from the continuous digester to a Hydrapulper for treatment for about 15 minutes. If the pulp suspension could be kept hot, less undigested fiber would appear in the screenings. They felt that it was not desirable to install a batch step in the process. I also discussed with them the causes for slow drainage of straw pulps. They have followed up this matter by correspondence and now say that they have taken my advice about using more open-mesh wires on washers and deckers to free the pulp of fines and have in this way increased the freeness from 56 S.-R. to 32 S.-R.--still a slow pulp by our standards.

<u>Papeteries du Marais et de Ste. Marie</u>, Office at 3 Rue du Pont-de-Lodi, Paris (6e), Pulp and Paper Mill at Boissy-le-Chatel, Seine-Marne. Mr. Charles Pinat, Director-General.

This is a very old company, having been in the same family since the 1700's. The company has two mills, one a 100-percent rag mill which is manufacturing the French currency paper and the other a mill making fine bleached papers and manufacturing bleached straw pulp. I visited this latter mill, located about 50 miles from Paris, with Messrs. Pinat and Sirvin.

Mr. Pinat visited Peoria in 1948 to discuss with us the neutral sulfite process for pulping straw, stating that he had read our papers on the process and wished to use it.

This mill, which is about 200 years old, has two paper machines with a trim of about 80" each. One of the machines makes bleached fine papers of up to 50 substance weights and the other from 50-150 substance. Both machines, while old, are in excellent operating condition. Both bleached softwood kraft and sulfite pulps are purchased from Sweden and Finland and poplar mechanical pulp is purchased in France. In most papers, up to 40 percent is made up of bleached straw pulp which is cheaper than the imported bleached pulps. Paper made for IBM (International Business Machines) does not use straw but is made 100 percent from imported sulfite. IBM paper is very difficult to manufacture. For this purpose a new finishing calender has been installed that is electronically operated to control thickness (capacitator). The continuous graphic record of the thickness of paper in each roll is shipped to IBM with the roll. So far no rolls have been returned.

The whole mill is kept in a most orderly and clean condition. Much of the paper is cut into ream folios and is inspected by women, sheet by sheet, in a large humidity-controlled room. The production of the mill is about 70 tons per day.

This small mill has a very well equipped laboratory with a graduate chemist in charge. The British sheet machine is used for making handsheets. A controlled-humidity testing room and a dark room is provided. Mr. Pinat is evidently sold on research and control. In the paper mill, a paper-testing station is located at the dry end of each paper machine and samples are tested at regular intervals.

Straw is purchased at about $8.50 per metric ton delivered. It is all procured from farmers within a radius of 10 kilometers. Only dry, well-baled straw, stored under dry cover, is purchased. Straw is delivered to the mill in 10-ton trucks daily. Transportation by railroad is entirely too expensive. Enough straw to keep the mill operating for two months is stored in a brick warehouse on mill property. There is no difficulty in procuring straw and the straw does not contain pith such as that obtained by Cellulose de la Seine.

The straw pulp mill is outstanding because of simplicity of equipment and operation. It is the second mill in France to produce bleached straw pulp and the first in Europe to use our neutral sulfite pulping method.

Straw bales are placed on a conveyor at about floor level, the wires removed, and the straw is chopped in a Nyblad straw chopper. This chopper is claimed to be simpler to operate and more satisfactory in every way than the Grumbach. The blades are sharpened after chopping each 5 tons of straw. The chopper has a capacity of 5 tons per hour, producing straw mostly from 1 to 3-1/2 inches long. The straw is sucked by a large fan from the bottom of the chopper housing to a bin on top of the digester house. From this bin, dust is discharged through a cyclone. The straw is fed from the bin by a star feeder to a mixing trough into which hot cooking chemical is pumped. It is said to be very important to impregnate the straw with chemical. Ninety percent of the chemical is added in this stage and the remaining 10 percent to the digester. The rotary digester has a capacity of 24 cubic meters and is filled with 4 metric tons of straw and 10,000 liters of liquid. The chemical consists of 10 percent Na_2SO_3 plus 5 percent NaOH on the basis of dry straw. The straw, impregnated with chemical is fed from the mixer by the mixing screw onto a rubber belt which carries the material to the digester. The digester is packed by use of a hydraulic ram similar to that used in all of the mills I visited which cooked straw under pressure.

The cooking cycle: 1-1/2 hours for filling and closing; 2 hours to heat to 170° C.; 3 hours at 170° C.; 1 hour to cool and empty. To empty, cold water is pumped into the digester to lower the consistency in the digester stock chest to 6 percent and to cool the pulp.

I told Mr. Pinat that in Peoria we found 2 hours'cooking at 170° C. was ample time for obtaining strong pulp. I said also we recommended the use of soda ash instead of caustic soda. Since my return Mr. Pinat has written that they have experimented with shorter cooking time and have been able to reduce the cooking time 1 hour without observing any modifications in the pulp. With two digesters they can now handle 7 cooks per day instead of 6. He is grateful for the advice.

The pulp from the digester stock chest is pumped to a screw press where the pulp is raised to about 25 percent consistency and the black liquor is separated. The pulp from the first press is mixed with water in a small mixing trough and passed through a second screw press. The same type of screw press is also used for washing bleached pulp. These presses are made by COLIN in Paris and have a capacity of 500 kg./hr. of pulp, and are said to be much better in design and operation than those used in the CELDECOR plants or those of German manufacture. I examined the nodes in the pulp coming from each of these presses and am satisfied that the nodes are not disintegrated in dewatering in

these presses nor were they disintegrated in the presses in the CELDECOR plants. This observation is important in connection with the design of plants pulping straw by the mechano-chemical process.

The pulp from the second screw press passes to a mixing trough where it is diluted to about 1 percent or less consistency, from which it is pumped continuously to a new type of screen and disintegrator combined. The accepted pulp passes through 3-mm. screens and is pumped to two centrifugal cleaners. The first centrifugal is provided with a screen 14/10-mm. mesh and the rejects from this pass to the second having a screen 12/10-mm. mesh. The rejects from the disintegrator and the second centrifugal cleaner are returned to the digester through a rotary drainer and recooked. I told Mr. Pinat that in my opinion these rejects should not be repulped because the fine fibers obtained from them only slow up the drainage of the pulp and make for slower paper-machine operation. The European mills almost universally run their machines at low speed, being more concerned with quality than production capacity. This idea will change as competition increases and as the few faster-running new machines being installed in Europe come into production.

The disintegrator screen is called DISINTEGRATOR LAMORT BTE. made by VITRY LE FRANCOIS, Marne, France. It is a low-cost machine having a capacity of 300 to 500 kg. pulp per hour. The centrifugal cleaner is made by MIAG, BRAUNSCHWEG, Germany. It also has a capacity of 500 kg. per hour. The black liquor from the first screw press is passed over a homemade vibrating Fourdrinier wire screen and until recently was evaporated and burned. No chemicals are recovered from the ash. This is an expensive operation, with high costs for oil and maintenance. A trial is being made of spraying the black liquor on waste land.

The accepted pulp is passed through a riffling system (they expect to replace this with a mechanical system) in which nodes and sand separate, and then through a French modification of a Dirtec system.

The pulp is bleached to a brightness of 80-82 for 4 hours in one stage in a large tile-lined Bellmer bleacher at a consistency of 4.5 percent, temperature 45° C., using 6.6 percent Cl_2. The calcium hypochlorite is made in the mill. Mr. Pinat said they would like to bleach at higher consistency but 4.5 percent is all that can be handled by their pump. The bleached pulp passes through two screw presses in series, with dilution between the first and second press, and the washed pulp is diluted to about 4 percent consistency, pumped to the paper mill, and formed into laps on a wet machine. The pulp is generally disintegrated at once in a 14-foot Hydrapulper for use on the paper machine. The various other pulps used in any particular paper machine furnish are also added and blended in the Hydrapulper for about 15 minutes. This is the first Hydrapulper installed in France.

I discussed the mechano-chemical process in which there was considerable interest. Mr. Pinat may experiment with the process. He is planning to double the capacity of the straw pulp mill. He considers the use of straw pulp both economical and beneficial for high paper quality.

In his office Mr. Pinat exhibited papers made by his company with historic watermarks antedating the French revolution.

Mr. M. Argy, Director, LA PAPETERIE (the leading French paper journal), 9 Rue Lagrange, Paris 5e.

Mr. Argy has for many years been editor of LA PAPETERIE. He is 74 years old and is retiring presently. I questioned him about a number of processes. He stated that the ABI, an Italian process using calcium bisulfite as cooking chemical with a high ratio of combined lime, had been tried for pulping straw and was no good. This confirmed my belief. He was not familiar with the proposed Fibropulper process, but stated that the Giro process (Italian) was only a modification of the neutral sulfite process. This confirmed what I had been told in Milan. He said a French nitric acid process produced a pulp from straw that required very little bleaching and used only a little caustic soda. The fact that the process required equipment made of stainless steel and that its operation was radically new made the situation such that no one wanted to be the first to try it out.

Mr. Pierre Delcroix, 13 Rue Spontini, Paris 16e.

Mr. Delcroix had tried to organize a technical association in the French paper industry like TAPPI but antagonism from executives in the industry had caused the movement to fail. He is now interested in a nitric acid-pulping process (referred to by Mr. Argy) which he claims makes a very free and white straw pulp.

The process is run entirely in the cold (15° C.) and for this reason he claims that only nitration of the lignin takes place, no oxidation is involved, and oxides of nitrogen are not formed. The straw and 42 percent (30° Bé.) nitric acid is introduced into the bottom of a stainless-steel tower. The introduction of air is avoided. The ratio of solid-to-liquid is unimportant and no heat is generated in the process. About one-third of the way up the tower, nitric acid is drawn off through a screened annular ring and is reused to treat more straw. Water is sprayed onto the straw at the top of the tower from which the straw is discharged. The water displaces the nitric acid and the liquid level is maintained about one-third of the length of the tower from the top. It is not clear how this is done nor what disposition is made of the dilute nitric acid.

The discharged pulp is extracted with 1 percent caustic soda on the basis of the dry pulp. The pulp needs only 3 percent chlorine in a three-stage bleach process. The NaOH neutralizes the nitric acid left in the pulp and extracts the nitrolignin, which has a very high molecular weight. The nitrolignin can be precipitated from the alkaline solution with water. It filters easily and contains 6.5 percent N on the dry basis. No good use for it has been discovered. The yield of pulp on the basis of straw is 22 to 23 percent.

Mr. Delcroix says that during the coming summer it is planned to build a small pilot plant to produce 200 kg. pulp per day to iron out mechanical problems. Next, it is planned to build a plant with 3 tons' capacity to be followed by one of 30 tons' capacity. The plant equipment will be lined with polyvinyl plastic. He promised to send me flow sheets and samples of pulp.

He said Centola's new process uses NaOH plus S or CaOH plus S, which has been confirmed. He said further that the ABI process is no good for straw, and this is true of all acid processes except nitric acid.

Papeteries de France, 10 Rue Commines (ille), Paris. Mr. Andre Tourreil, Manager.

This is a very large paper company with several (5 or 6) mills. My visit was to the mill located at D'Alfortville just outside of Paris. Mr. Edgard Harari, who visited Peoria, had left the employ of this company but he accompanied me and Messrs. Sirvin and Tourreil on the mill visit.

This mill for the most part is new. I was particularly interested in seeing the continuous Kamyr digester and had arranged this visit from Peoria. I was provided with a complete flow sheet of this process and shown all the equipment. This plant is being built of stainless steel since plans are to use an acid process or semichemical neutral sulfite. The material to be pulped is a local hardwood. The first process to be tried is the WABI, which is the ABI process (high combined calcium bisulfite) as modified by Waldhof of Germany. The use of the semichemical process (sodium sulfite and soda ash) is also being considered. To date, only preliminary experimental work has been carried out. This installation appears to be very expensive. As was the case with the Kamyr process at Vita Mayer, no royalty is being charged, the understanding being that the installation is experimental and that Papeteries de France will permit anyone to visit the installation and will disclose operating data.

The company has also installed a new board machine with a trim of about 2 meters (80 inches). This machine has 6 cylinder vats and is also provided with a Fourdrinier wire. The cylinders and Fourdrinier wet ends can be run separately or in combination. At the time of my visit, both parts were being run, the Fourdrinier being used to form a white liner, while the cylinder formed board, and both sheets being combined before the last suction box. A small Yankee dryer is installed in the position in the dryers where the size press is usually installed. Water is sprayed onto the liner side of the board just before it comes to the Yankee dryer so that a machine glaze is produced on the white liner surface. The machine room for this new board machine is well laid out.

At the time of my visit the paper industry was operating at about 60 percent of capacity only.

I discussed the mechano-chemical process and the use of straw to make strong board. They were much interested and asked me to send them reprints and samples.

Societe Anonyme des Papeteries Darblay, Paris Office, 27 Rue des Pyramides, Plant at Essonne, Seine et Oise. Mr. S. Darblay, President, Mr. Villare, Plant Manager.

I was interested in seeing the operation of the Hugenot process used for pulping straw for strawboard manufacture. We had correspondence with Mr. Darblay concerning the use of straw in the manufacture of newsprint and finding that his mill was operating the Hugenot process, I wrote to him asking permission to visit the mill. In Paris Mr. Darblay wrote that while the Hugenot process was not presently being operated, he hoped very much that I could visit him and discuss the utilization of straw for papermaking. Accompanied by Mr. Sirvin I visited this mill, located about 20 miles outside of Paris, and met Messrs. Darblay and Mr. Villare, technical manager. These men were very much interested in the work of the Northern Laboratory and discussed the various problems rather thoroughly. They asked to be supplied with reprints of our papers.

Mr. Darblay stated that his company had discontinued the use of the Hugenot continuous pulping process, since it was not satisfactory and the process equipment was very badly designed and poorly constructed. Instead, they had then installed the Morley continuous process, developed by the Thames Board Mill of England. He thought this process was very little improvement over the Hugenot process. Difficulty has been experienced in drying the paper made from the Morley pulp. I pointed out that Morley uses 10 percent caustic soda to produce a corrugating pulp, whereas in Peoria we had found 6 percent caustic soda sufficient. The excess caustic caused a loss in yield and produced a slow-draining pulp which was the reason for poor drying. I suggested that he arrange to cook with less chemical. It is possible that this company may become interested in the mechano-chemical process.

BELGIUM

December 27-30, 1952:

L'Union des Fabriques Belges de Textiles Artificiels, ("FABELTA"), 43 Rue lules Legeune, Brussels; Factory, Zwynaade. Dr. Jacques Mockel, Directeur Recherches et du Controle, Dr. Jean Ghosez, Directeur de FABELTA, Zwynaade.

Drs. Mockel and Ghosez met Dr. J. Raick, managing director, Syndicat de la Cellulose Africaine, Dr. J. R. Istas, ministere des Colonies, Laboratoire de Recherches, Tervuren, and me at my hotel in Brussels and drove us to the factory at Zwynaade, located about 4 miles from Ghent. FABELTA is one of the directing interests in the Syndicat de la Cellulose Africaine and has carried on some research on papyrus as a

source for rayon pulp. FABELTA is the largest rayon company in Belgium, having five plants. The plant at Tubize is their oldest and at this plant is located their Central Research Laboratory. FABELTA is a pioneer in rayon manufacture and makes about 2 percent of the world production of rayon fiber. The factory at Zwynaade produces 50 tons of staple rayon fiber per day. At this plant there is located a control laboratory and a pilot plant with complete facilities for making xanthate and producing finished staple rayon fiber. Process research is carried on at this plant.

The plant control and final testing of the fiber is most complete. The physical-testing laboratory is very large. It is mostly staffed with women. A composite sample of rayon staple fiber is collected on each 8-hour shift and is sent to the laboratory. Here determinations of fiber length and fiber diameter are made by several methods. The average fiber diameter is determined by an electronic capacitator method. The percentage of neps and other impurities are determined by hand examination. Wet and dry tensile strength and coefficient of friction of the fibers are determined. A horizontal method for determining the tensile strength of fiber under regulated increasing tension is also used. The ability of the fiber to withstand rapid winding, either under constant or under increasing tension, is measured. The results of these tests are related both to a control of manufacturing operations and to particular customer specification requirements. I did not have time to discuss the details of the tests with which I was not already familiar or to obtain the names of the instrument manufacturers.

A trip was made through the entire manufacturing operation, at which time the various process steps were explained in as much detail as desired.

All of the alpha-cellulose dissolving pulp is imported. Sulfite pulp is obtained from Rayonier, Inc., U.S.A., and from Sweden and Finland. In addition, "Cordicelle" prehydrolyzed sulfate pulp from Sweden is used for tire cord rayon and a shipment of similar pulp from the Natchez, Mississippi, U.S.A., plant of the International Paper Company was on hand but had not yet been tested. The specifications of the highest grade rayon-dissolving pulp are: Ash, 0.3 percent; pentosans, 0.5 percent; for staple grade, pentosans 1.0 to 1.5 percent, alpha-cellulose 89 to 90 percent.

The manufacturing process is continuous. The bales of cellulose pulp are opened, the sheets of pulp are passed into a chopper, and the chopped material passes into a machine into which caustic soda solution (250 grams NaOH per liter) is pumped. The machine converts the dry pulp by mixing under pressure into a pulp slurry having a solids-to-liquids ratio of 1:40. The slurry is pumped to a large tank for blending, after which it is diluted with filtered water to a 1-percent consistency and pumped to a wet machine, consisting of a vacuum filter equipped with press rolls in the form of belts which press the

pulp sheet on the filter wire. The pulp sheet comes off the wet machine 20 percent dry cellulose and, after passing through a second press, comes off 30 percent dry cellulose containing 16 percent NaOH. Several different types of pulp are slurried and blended together.

The pulp wet laps are shredded and weighed into mixing bins. The mixed pulp is weighed again and stored about 6 hours at controlled temperature to age and depolymerize the cellulose. The starting D.P. of the cellulose in the wet lap is about 800 and the aging results in a D.P. of about 350 which produces the correct viscosity in the xanthate solution. The continuous process for preparing the alkali cellulose is called the Woulf process after the name of the wet-machine filter.

The ripened alkali cellulose is converted into xanthate in batch converters, which hold about 3-1/2 metric tons of alkali cellulose containing about 1 ton cellulose. Carbon bisulfide is added in slight excess and allowed to mix in the converter for about 3 hours, after which time sufficient caustic soda solution is added to the converter to bring the xanthate into solution.

The xanthate solution is pumped to a storage tank and is immediately filtered through plate and frame filters using cotton duck filter cloths. These cloths are washed and reused about 20 times. The filtration of the viscose solution is extremely critical and is particularly influenced by the presence of pentosans or other short-chain polymers. The schedule of redressing the press is based on pressure rise in the press.

The filtered viscose solution is stored under 100 mm. pressure in a vacuum tank for about 16 hours to allow all air and gas bubbles to be removed. The viscose then is pumped to the spinnerets through filters. While the viscosity of the viscose is controlled by D.P. of the cellulose, the solution must contain some carbon disulfide as it goes to the spinnerets, since the cellulose xanthate is continuously in an unstable state.

The spinnerets, about 3" in diameter, are constructed of platinum and each contains either 16,000 or 20,000 holes. These are manufactured at the local rayon plant. The spinning bath consists of a solution of sodium sulfate with some zinc sulfate and sulfuric acid. It contains no glucose. The fibers from the spinnerets are collected, and under tension, drawn over flat mandrels to form a band of parallel fibers about 1-1/4" wide. These strands are kept under high tension during both washing and cutting operations. The strands are cut into about 2" lengths by revolving knives and the cut pieces fall onto a moving rubber belt where they are uniformly distributed with a moving arm. On this belt the material is sprayed with dilute sulfuric acid, is then washed, treated with a dilute soap solution to improve the "hand" and finally dried to 2 percent moisture content by passing through a multi-pass dryer under controlled temperature.

The dried fiber is passed through an opening machine to separate the fibers from the bundles and is then made into 200 kg. bales, wrapped in burlap. Ninety percent of the production of this factory was being shipped to the United States, on which an advalorem duty of 20 percent is collected.

The staple fiber, while it does not pass through a bleaching operation, is very white. It is extremely soft, and due to the combination of tension and acid treatment, the fiber possesses a slight curl or twist. One of the machines was producing a brown staple fiber, the dye being added to the viscose before spinning. Black and dark-blue shades are also produced in this way.

The spinning bath chemicals are recovered in a continuous operation consisting of triple-effect evaporation, crystallization, and filtering. About 1 pound of sulfate salt is produced per ton of fiber made. The crystalline salt is obtained as $Na_2SO_4.10H_2O$. There is an excess of 35 to 40 percent salt recovered over that used, the excess of salt being thrown away since it is too expensive to dehydrate and no market exists for it. The caustic solution recovered from the preparation of the alkali cellulose is dialyzed to remove pentosans and other organic impurities, using parchment for dialysis membranes. The caustic solution has become diluted from its original 250 gms./l. to about 115 gms./l. The dialyzed caustic may be even more dilute since it is used in washing the stack gases from the factory, particularly to remove sulfur compounds.

After the plant and laboratory visits, I had an opportunity to discuss the subject of dissolving pulp from papyrus with Drs. Mockel and Raick. I wanted particularly to obtain the reaction of Dr. Mockel to the question of pith. I asked first if the action of caustic soda on the cellulose might not be a surface reaction, stating that if this were so then the pith, because of its greater surface, would react more rapidly than the true fiber, so that the degree of depolymerization would depend to a considerable extent on the actual pith content of the alpha pulps, which was bound to be variable. This, in turn, should have an influence on xanthation rates and on filtration characteristics. Dr. Mockel thought that the pith would react more rapidly and said that he had been wondering about the behavior of pith, particularly on filtration characteristics. In the plant trip filtration had been described as being of critical importance. I mentioned also the effect of pith in collecting dirt and, hence, in making ash removal and bleaching more difficult. To this analysis he agreed. I then discussed our work on pith removal and the effect of pith on pulp characteristics and stated that I proposed to recommend to Dr. Raick that, since this was a subject we were especially prepared to study at Peoria, he should authorize work along this line in their Peoria program.

<u>Papeterie de Belgique</u>, Duffel les Anvers. Mr. M. Vincent, Managing Director, Mr. Centerick, Research Manager.

This paper company is also a member of Dr. Raick's syndicate and has been carrying on research in evaluating papyrus pulps from the standpoint of their papermaking qualities. The pulping of the papyrus, it was discovered, was being carried out at the FABELTA Central Research Laboratory at Tubize by a chemist assigned on loan to Dr. Raick. This chemist had experience in evaluating pulps for rayon but not for paper manufacture.

Dr. Raick arranged, at my request, therefore, to return by auto to Brussels by way of Duffel. Mr. Vincent had visited Peoria and was very cordial. His company is the largest one producing paper in Belgium and operates several mills, one of which makes newsprint and produces 200 long tons of mechanical pulp per day. The remainder of the pulps, sulfite and kraft, including waste papers, are purchased.

Four paper machines are located at the Duffel mill which makes a variety of papers and boards in various weights. Their most interesting paper machine is provided with two Fourdrinier wet ends, one placed one floor above the other. The two sheets are combined on the under wet end of the lower machine just before the last suction box prior to the couch roll. The drying of this combined sheet must be carefully controlled to prevent the sheets from separating, due to the formation of steam pockets between them (called "blowing"). The paper machine is provided with a Yankee dryer about five-sixths down the length of the dryer chain. Just before the board reaches the Yankee dryer, water is applied to the side of the paper coming in direct contact with the dryer surface. This produces a highly glazed "wet" finish on the board.

Mr. Vincent said that the Belgian paper industry was operating more fully than the French but that prices were low, labor benefits high, and operation was below the capacity at which profit was possible. While his mills are not located so as to obtain straw economically, he was complimentary about our Peoria Laboratory developments.

The Central Research Laboratory of this company is located at the Duffel mill as is also a control laboratory. Mr. Centrick showed me through these. They are commodious, well arranged, and very neat and clean. For research, two electrically heated digesters are available, one with a capacity of 8 liters, the other, 3 liters. No provision is made with either for blowing cooked pulp. The small pilot-plant equipment for pulp disintegrating, washing, and screening is either of German or Swedish make. The Schopper (German) sheet machine makes a round (8") sheet which is dried at 100° C. under 100-mm. mercury vacuum. This appears to be an excellent machine, quite rapid. Pulp strength is developed in the Jocro mill. They have a small setup for three-stage bleaching at high consistency. The

physical-testing laboratory is maintained at 65 percent R.H. and 20° C. The physical-testing machines, of which a wide variety are on hand, are of Swedish or German make. One of the machines called DRUKPROEFPPARAT and made by Institute Voor Graphiscke Technique, Amsterdam, is used for determining the printing quality of papers. A strip of paper about 6" x 1/2" is used. The machine is claimed to give excellent results.

I discussed with Drs. Centrick and Raick some of the test results on the pulps obtained from papyrus, especially from the roots. These results indicated that fairly strong pulps could be obtained in yields of about 50 percent. I pointed out, however, that the drainage rate of these pulps was so low that they would not be suitable to run on a paper machine. Dr. Centrick promised to send me reports on these pulps through Dr. Raick.

Ministere des Colonies, Laboratoire de Recherches Chimiques, 5 Rue de Moulin, Tervuren. Dr. E. Castagne, Professor of Chemistry, Dr. J. R. Istas, Agricultural Chemist.

Dr. Castagne had attended the FAO Rome Conference, December 1952, and Dr. Istas the conference at Appleton, Wisconsin, September 1951. This group is engaged in studying the papermaking resources of the Belgian Congo, especially the hardwoods and bamboo.

Through an arrangement by Dr. Raick, both Dr. Godefroid and Mr. Locus, working as trainees at the Northern Laboratory, had worked on papyrus in the Tervuren Laboratory under the direction of Dr. Istas. I visited the institute mainly on this account. The laboratory is very small, but is adequate for the work involved, although not yet fully equipped. The pulp-testing equipment is mostly of Swedish or German make. In addition to the Jocro and Lampen mills a TAPPI beater of Swedish make is installed. A very small conditioned testing room is provided. In addition, a small pilot plant for studying the manufacture of chemicals and charcoal from woods of the Congo is installed.

The tropical woods of the Congo show immense variations in their composition, especially their physical characteristics. Some are very dense and difficult to chip and to cook on account of imperviousness to penetration of cooking liquors. Others are of low density, containing large amounts of parenchyma cells. These pith cells cause the same difficulty in pulping as those of bagasse or papyrus. Since the forest stands consist of mixtures of these various species, it is difficult to consider the pulping of only one species, so that the practical problem is to discover how to produce satisfactory pulp from selected mixed species.

I discussed the papyrus problem with Drs. Istas and Castagne who stated that they had informed Dr. Raick even before he came to Peoria that, in their opinion, the pith in the papyrus would cause trouble and that a method for removing it should be explored. Evidently this recommendation had not greatly impressed Dr. Raick.

<u>Syndicat de la Cellulose Africaine</u>, 95 Avenue Louise, Brussels. Dr. J. Raick, Managing Director.

After my visit to Tervuren I spent some time with Dr. Raick in his office discussing the papyrus problem. I called his attention to the discrepancies between the results obtained in Peoria and those in Belgium and suggested that he send more details of the analyses and analytical methods, and that, further, there might be an exchange of pulp samples between the two groups so as to make sure that both laboratories were in accord. He stated that he had already sent Dr. Aronovsky much complete data.

I discussed the results that Tubize had reported on pulping the roots with sulfate chemicals for 15 minutes at 150° C. with a yield of about 50 percent. This pulp was claimed to have good bursting strength. I pointed out that the pulps, without beating, had a freeness of 43 to 48 S.-R. while Swedish sulfate pulp tested 15 to 20 S.-R. Therefore, these pulps drained so poorly that it would be impractical to run them on modern high-speed paper machines. Peoria tests on the roots after my return showed that the roots had no value for papermaking.

At FABELTA and Papeterie de Belgique I had discussed the problem of pith in papyrus both with respect to rayon and paper pulp. Dr. Mockel of FABELTA stated that he would like to have Peoria examine the matter of pith removal and wanted to test pulps, as to their suitability for staple rayon manufacture, made from the whole papyrus and from papyrus fiber free from pith. He said 10 pounds of each pulp would be required. Mr. Centerick of Papeterie de Belgique also thought that such a program of tests would be logical.

I discussed this matter at greater length, stating that the Northern Laboratory was in a position to make a real contribution to their problem in determining the effect of pith on the quality of papyrus rayon and paper pulps. Dr. Raick suggested that on my return to Peoria we make a written proposal to him on this subject so that it could be presented to his directors. The program involved a continuation at Peoria of the Belgian trainees for an additional six months. Dr. Raick also desired us to give him a flow sheet for the entire pulping process but I said that our work and that of his trainees had not been sufficiently complete or detailed to warrant such a flow sheet.

Although at the time of my discussion on this day, December 30, 1952, Dr. Raick had already given written notice to his trainees that their stay would terminate on March 31, 1953, he did not mention this matter to me. As later events proved, it had been decided then to discontinue the project.

NETHERLANDS

December 30, 1952-January 7, 1953:

Vezelinstituut, T.N.O., Mijnbouwstraat 16a, Delft. Dr. G. van Nederveen, Director of Paper Investigations, Dr. Royen, Director of Paper Research, Mr. Hellenberger, In Charge of Pulp Testing.

This institute is engaged in fiber research and development work for the textile and paper industries. For the paper industry, its attention is directed more towards papermaking and the uses of paper than to the problem of pulping. It cooperates with Nederlands Proefstation voor Stroverwerking, located at Groningen, in connection with the utilization of straw. Dr. Muller, director of this latter station, suggested that I visit Dr. van Nederveen. Dr. Julius Grant also had written from London asking if I could not visit Delft.

Seven men are engaged in this paper research work. The small, but well-equipped, pulping and pulp-testing laboratory for pulp-strength development is provided with the Jocro and Lampen mills and with a Swedish-built TAPPI beater. They use Swedish-made disintegrator, screens, clarifier, and sheet machines. Several small pressure digesters are available, as well as a humidity-controlled physical-testing laboratory. A small paper machine and 3-foot Hydrapulper are located in another part of the institute, which was closed due to the holidays.

Dr. van Nederveen is interested in the mechano-chemical process and was making a study of esparto pulping by this process for Dr. Grant of England. He stated that the esparto grass was dirty and contained a large amount of roots. Dr. Grant had asked that unchopped esparto grass be added to the Hydrapulper and also that a minimum of water be used in washing the pulp. Cooking with 10 percent of caustic soda, based on dry esparto at 10 percent (?) consistency, the grass had been pulped for 1.5 and 2.0 hours. A pulp yield of 55 percent was obtained which bleached only to a yellow white with 5 percent chlorine. I told Dr. van Nederveen that if raw material could not be pulped in 1 to 1.25 hours, the amount of chemical was too low, and, therefore, to obtain a satisfactory pulp from esparto the amount of chemical should be increased. I discussed most fully our work with the process. Later in England, I learned that the 3-foot Hydrapulper had too small a motor and the pulping was probably at 6-percent consistency. This problem will be discussed later. The men at the institute were most cordial and were very much interested in our work in Peoria.

I arrived in Groningen the night of January 1 from Amsterdam and made this place my headquarters. Dr. F. M. Muller, director of the Straw Utilization Experiment Station, had been a member of my committee at the FAO Rome Conference. He arranged for me to visit in his company, not only his experiment station but also the more important straw pulp, paper and board mills, located for the most part in the province of

Groningen. We generally visited two mills each day and met with mill managers a few evenings. Due to these courtesies I was able to see the more important aspects of this industry, which represents the widest in kind, most up to date and concentrated use of straw for papermaking in the world.

Erica II. Strawboard and Paper Mills, Winschoten. Mr. Smit, President, Mr. Hamster, Superintendent.

This company, which has two mills, is fairly representative of those that manufacture container board by the lime process from straw. The Erica II mill is integrated with a boxmaking department. Eighty percent of this board production is converted into boxes, particularly for shipping margarine. The remaining 20 percent is exported in the form of paper board to England, Australia, and India. The manufacture of straw pulp in the Netherlands has greatly increased since the war while the exports, particularly to England, have fallen off.

Only dry straw is used for paper or board manufacture. This is stored, in 110-pound wire-bound bales, either in the brick barns on the farms, or in brick warehouses at the mills. Erica II was paying $10 per metric (long) ton for straw. Straw this year was somewhat scarce in the Netherlands because of export to Germany, Switzerland, Belgium, and France where it was being used for bedding. Some combine harvesters are being used in Holland, but when at least $10 per ton is paid for the baled straw the farmer is willing to bale with the stationary baler and not use the combine. Absentee ownership of farms in the Netherlands is discouraged by fixed low rental prices for land and lower farm prices. Some large farms are using mechanized equipment. A farm of 4,000 acres is about as large as one farmer can handle alone. This mill uses rye, wheat, and oat straw regularly and sometimes barley straw. Oat straw gives a softer board but a smoother surface to the board than rye or wheat straw.

The preparation of the lime-cooked pulp at this mill is typical of the industry. The straw is chopped to 2 to 3" in length with a Grumbach chopper which is made by Noord-Nederlandse Machinefabrick, Winschoten, and sells f.o.b. Rotterdam for $570.00. This machine chops 1 bale (110 pounds) per minute using a 40-hp. electric motor. In this mill the knives are sharpened every 12 hours. The chopper is located in one end of a brick straw warehouse and the chopped straw is carried by a drag conveyer up to the loading floor of the digester house.

The straw is first conveyed into a mixing trough where it is mixed with milk of lime suspension from which it is conveyed mechanically to 14-foot rotary globe digesters. A mechanical ram is used for packing the straw into the digester. Burned lime is slaked using white water. The straw is pulped with 10 percent lime, based on air-dry straw, for 3 hours at a pressure of 60 pounds. The cooking cycle is about 6 hours. The thick mass of straw pulp from the digesters ~~is~~ dropped

batchwise into Kollergangs--one each per digester. In some mills a special automatic feed from digester to Kollergang is provided. This was seen in the newer mills. In other mills the straw pulp was dumped into piles and by screw conveyers carried to the Kollergang.

The Kollergang, while it is slow in action and uses considerable power, is useful in refining lime-cooked straw, since it crushes and defibers the straw without appreciable cutting action. The consistency in the Kollergang is 15 to 16 percent and each batch is treated about 15 minutes.

From the Kollergangs the straw is dropped into old-fashioned hollander beaters where the straw is beaten about 15-20 minutes at 4-5 percent consistency. No consistency controllers are used and the beating is under the manual control of the beaterman who removes fibers from the beater with an iron rod and by the feel of the pulp decides when it is satisfactory to drop the pulp into a paper-machine chest, where the pulp is diluted with white water to 1 or 2 percent consistency or less. From the chest the stock is pumped to a crude vibrating screen to remove nodes, large pieces of straw and other particles. The screened stock flows to the headbox of the paper machine.

Most of these strawboard paper machines make a narrow sheet of board and all operate at what we consider very low speed, e.g., about 225 feet per minute or less. The machines are all of the Fourdrinier type. There is no washing of the straw pulp so that the machine white water is extremely alkaline and dirty. While wires and felts plug up with lime deposits, no slime problems exist. The pulps are naturally very slow draining, and the sheet going through the presses to the dryers is higher in moisture content than in American strawboard manufacture. The boards made are calendered at rather high moisture content. Although they are not waterproof, because of the high alkalinity, they have a good surface and good physical properties.

In many mills these strawboards are laminated on one or both sides to kraft or sulfite papers. At the Erica II mill the laminating machine was a continuation of the paper machine. Boards up to weights of 1,000 grams per square meter are manufactured. During my visit the board made was laminated on one side to kraft paper and on the other to bleached sulfite paper. In converting this into boxes the bleached sulfite surface formed the outside of the box.

Not only was no waste paper used in making board, but the paper and pulp mill water system was completely closed so that no waste water ran into the canal. Fresh water to make up losses due mainly to evaporation was added at showers on the paper-machine wire. This is the only mill in Holland having a completely closed white-water system. The yield of pulp and paper based on straw is more than 100 percent due to the fact that all the lime salts and the fines and soluble organic matter are incorporated into the board.

"deEendracht" Strawboard Mill, Appingedam. Mr. Muntinga, Managing Director, Mr. H. W. F. Veldhamp, Laboratory Director, Mr. J. deHaan, Paper Mill Superintendent (one of the Netherlands group visiting Peoria, October 1952 TAPPI meeting).

I was particularly interested in visiting this mill since it makes bleached straw pulp by our neutral sulfite method and is beginning to export to the United States. Two other mills in Holland are producing excellent bleached straw pulp for export: "Phoenix," using the sulfate-pulping process and "Sove" the CELDECOR process.

Of the 19 mills in the Netherlands pulping straw, 11 are cooperative. Most of the mills are of 50 long tons daily capacity, and the farmers who are the directors of the cooperative mills are very conservative and do not want to spend money to modernize these.

"deEendracht," however, has a capacity of 100 tons production per day and a progressive board of directors. This mill originally used only the lime process, later changing in part to cooking with caustic and in 1949 undertook to cook with the neutral sulfite process. At first this process was used to make unbleached pulp required in its own boxboard manufacture. Then some of the pulp was semibleached and finally a four-stage Kamyr bleach system has been installed and bleached pulp is being dried, baled, and exported. The plant is going through the pains of being completely converted from strawboard to producing bleached straw pulp. The trip through the operation involved climbing many ladders and steep stairways. The plant now has a production capacity of 15,000 tons of bleached pulp per year and it is expected to double this eventually. Mr. Muntinga stated more than 8 million florin (about 2 million dollars) had been expended to date in the modernization.

About 60,000 tons of straw are collected annually within 15 kilometers of the mill. Straw yield is about 5 long tons per hectare (1.3 tons per acre). Straw is chopped by the Nyblad chopper and blown into either the strawboard or straw pulp mills. To make ordinary board straw is pulped with lime as in the Erica mill. To improve the character of the board pulp some straw, originally cooked with caustic soda, is now cooked with a mixture of sodium sulfide and caustic soda (sulfate process chemicals) for 3.5 hours at 15 pounds pressure using 6 percent chemical with a yield of about 60 percent. Neither of these pulps is washed before they go to the paper machine. The sulfate-cooked pulp is stronger and produces more rigid corrugating media than the lime-cooked straw. The rotary digesters are charged with straw soaked in the cooking chemicals and packed by ramming as in Erica II. The rotaries each dump into a compartment supplied with a conveyer which discharges the pulp at high consistency to a traveling belt feeding a Kollergang. Instead of using only Kollergangs to defiber the straw, this mill also uses some rod mills which they think makes for better quality.

In addition to these two pulps, washed unbleached neutral sulfite straw pulp is used for making board. This company has developed a line of higher quality specialty boards made from various blends of the three kinds of straw pulp they produce. In some very high-grade products they mix in also as much as 20 to 50 percent sulfate wood pulp. They also make laminated products similar to those of Erica II. In order to produce colored board, color is added to the water box before the Yankee dryer on the paper machine, and for water resistance wax emulsions may be added there also. These latter board products are made for export chiefly. A Hydrapulper is installed for defibering the caustic cooked straw and blending it with purchased wood pulps. This installation is followed by two Jones refiners. The paper machines are slow-running, narrow, and old.

The bleached neutral sulfite pulp mill is separate from the strawboard pulp and paper mill. Here 14-foot rotary digesters are used, the straw is wetted with chemical and the digesters filled by ramming. The straw is cooked with 12 percent sodium sulfite and 3 percent caustic soda. The liquids to solids ratio at the start of the cook is kept as low as possible (2 to 1) since direct steam is used for cooking. At the end of the cook the ratio is about 4 to 1 due to condensation. The digester cycle--2.5 hours to fill, 1-1/2 hours at full pressure (100 p.s.i.), and 1/2 hour to dump. It is believed that the temperature of the cook is 170° C. but the thermocouple which is located in a shallow well registers 165°-167° C.

The pulp is blown from the digester to a blow tank to explode the nodes. Mr. Muntinga said he obtained this idea from our paper on neutral sulfite pulping of straw. In order to blow the pulp from the rotary a fixed pipe is led from one of the trunnions to the bottom of the rotary. The outlet end of this pipe is expanded to fit over a fixed cone on the digester side, so as to restrict the opening into the pipe somewhat and thus increase the velocity of entrance of the pulp. The digester is blown at full pressure, using steam introduced through the other trunnion. Even then, the digester is not blown clean nor are all the nodes completely exploded. The pulp from the blow tank is pumped to Jonsson screens with screen plates having 5-mm. holes, the rejects from this primary screen passing over a secondary Jonsson with plates having 1-mm. holes. The rejects from the secondary Jonsson are sent to the board mill. The accepted pulp from the primary Jonsson is passed through an AMPMEW screen, Swedish-built, having plates with 0.3-mm. (8/1,000th) holes, and the rejects from this screen are recycled to the primary Jonsson. This system does a good job of screening, there being very few shives in the screened pulp. The yield of unscreened pulp is 46 percent based on straw and the screen yield 42 percent.

The pulp is bleached in a four-five-stage Kamyr system, using a total of 5 percent chlorine. In the first stage at 3.5 to 4 percent consistency 60 percent of the chlorine is used. The chlorinated pulp

from the first tower is passed to a vacuum washer where, in addition to washing with water, the pulp is sprayed with dilute (10 percent caustic soda solution) followed by a water spray. Mr. Muntinga is not satisfied that enough time is given at this point for the caustic to combine with the chlorinated lignin compounds. After washing, the pulp is bleached in separate towers in two stages with calcium hypochlorite at 6 percent consistency with no washing in-between. The pulp is then washed on a vacuum washer and is pumped to the Fourdrinier board machine. The pulp sheet is dried over cylinder dryers, extreme care being taken not to dry the pulp below 14 percent moisture content, so as to avoid case-hardening the pulp sheet. The pulp board is sheeted and packed for export in 200-kg. bales. Some of the bleached pulp is sold in wet lap form. This is frequently pulp of a higher dirt count than is permitted in export pulp.

After this trip through the mill, the three representatives of Eendracht Dr. Muller, Mr. Smolder, Dr. Muller's assistant who accompanied us on many of these mill visits, and I discussed at some length the manufacture of bleached straw pulp. I discussed the reasons for slowness in pulps and said that the American paper industry would be interested in clean, easily wetted, strong bleached straw pulps. I suggested that by the use of less chemical, replacing the caustic soda with soda ash, that a freer pulp in higher yield could be obtained. This would require more chlorine for bleaching.

The Peoria Laboratory had reported to the Cellulose Sales Company of New York tests on samples of Eendracht bleached straw pulp obtained from them. This report called attention to the fact that the pulp was not as strong as that made at the Peoria Laboratory by our neutral sulfite process, and had been forwarded to Mr. Muntinga who was considerably concerned about the matter.

I discussed our effort to interest the American paper industry in undertaking the use of straw, saying that we had in mind suggesting to them that they purchase Eendracht pulp for paper-machine trials, since no facilities had been found in the United States to prepare 50 or 100 tons of bleached straw pulp by our methods. We had, however, shown that it was possible to make much stronger straw pulps than exhibited by the export samples and we feared that, unless we could explain to the American mills beforehand the reason for the lower strength of the Eendracht pulps, the trials would fail in their purpose of interesting the American mills.

Dr. Muller and I had previously discussed my proposal that his laboratory and ours run tests by his continental and our TAPPI methods on the same samples of pulp, so that a better understanding could be had of what these tests mean in terms of each other. To this idea he agreed and we decided that we would jointly request from each of the Holland bleached straw pulp mills samples both of wet lap and commercially dried pulps. Dr. Muller would arrange to collect the pulps,

divide them, and ship our half to us. We propose to prepare a joint publication on the results. This is of considerable interest to FAO, who might want one of these pulps as a standard for comparison purposes.

We discussed this idea with Mr. Muntinga, who was greatly pleased, and indeed offered to give for FAO purposes to Dr. Muller a ton of dry bleached straw pulp.

The conversation was so interesting to Mr. Muntinga that he and I continued it through dinner. He said that the European market was not particularly concerned with the strength of straw pulp but rather with its softness. He has much interest in the fact that the mechanochemical process would produce a very strong bleached straw pulp and said that he might be interested in producing a strong pulp of this sort.

N.V. Stroostoffabriek, "Phoenix," Veendam. Mr. B. A. Poulie Wilkens and his son.

This mill, which has been producing bleached straw pulp since 1890, was started by the Wilkens family. The day I visited the mill, the last original digester (about 9 feet in diameter) was being removed. The mill is being modernized in many respects. The new digesters are 14-foot diameter rotaries which will withstand 12 atmospheres (absolute) pressure. These digesters are equipped with blow lines to a blow tank. The present production is 40 long tons bleached pulp per day, and the expanded facilities will provide 50 tons per day production.

This mill, like most in Holland, stores 8,000 to 10,000 metric tons of straw in brick warehouses on the mill property to cover any emergencies. The straw formerly was delivered by canal on barges, but today delivery is made mostly by trailer trucks (10-ton capacity). "Phoenix" prefers rye straw and obtains mostly this kind, but takes what the farmer delivers, e.g., wheat and even some oat straw.

The straw is chopped in a machine like the Grumbach, but built by "Phoenix," and is carried to the top of the digester house with a drag conveyer. The straw is merely dusted and not put through an elaborate cleaning system. Straw and the pulping liquor are poured into the digester together and the digester is packed with a ram. The sulfate process is employed for pulping; this is said to be the only mill using this process. Fourteen percent chemical (33 percent sulfidity) is used on the basis of air-dry straw. The cook is for 3 to 4 hours at the full pressure of 5 atmospheres (absolute). The whole cooking cycle is about 5 to 6 hours.

The pulp from the digester is diluted and washed over two vacuum filters, the pulp lap coming from the filter at 16 to 18 percent consistency and free from any alkaline taste.

The pulp from the washer is diluted and is screened over an old German-make vibrating screen, something like a Jonsson. The bottom of the screen, however, is flatter and the screen is wider and almost completely submerged. The screen plate has 5-mm. holes. The rejects pass from one screen to the next of the pair. This screen does a remarkable screening job and has a high capacity.

The pulp is bleached to a brightness of about 84 with 4 percent chlorine in a three-stage operation. In the first stage, 45 to 50 percent of the chlorine as gas is used at about 3.5 percent consistency. The pulp is washed, given an extraction with 1 percent caustic solution, washed again and then treated with the remainder of the chlorine as calcium hypochlorite. Vacuum filters are used as washers. The yield of bleached pulp, as near as I could find, is about 38 to 40 percent.

The pulp is formed into a pulp sheet on a Voith paper machine. The pulp, both in this mill and at Eendracht, is cleaned by passage through a "Dirtecs" system before going to the machine headbox. The pulp sheet is dried carefully over cylinder dryers to 14 percent moisture to prevent casehardening. The pulp is sold on a 12-percent moisture basis, but is never this dry. Pulp is baled in 200-kg. bales. The paper-machine room is of very modern construction, is well lighted, and is very clean. The pulp appears to be of excellent quality.

Next to this machine room is a very large storage warehouse for baled pulp. I noted "No Smoking" signs which I had not seen in the mill proper. Mr. Wilkens said that these were a war relic. The floor of this warehouse for months had been covered with straw on which refugees coming back from Germany had slept. Mr. Wilkens said that in spite of everything, some people would smoke and that he was always afraid of fire.

This straw mill was the only one visited that recovers chemicals. Chemical recovery has been practiced here since the early days of the mill, the first installation being extremely primitive. Now the black liquor from the washers, received at 8° Bé., is evaporated in a quadruple effect to 18° Bé. Mr. Wilkens says it does not pay to evaporate further. This thick liquor is burned in a rotary. A waste heat boiler is not used with the rotary. The smelt from the rotary falls into a dissolving tank holding water and the green liquor is treated in settlers with milk of lime. The muds drawn off from the settlers are filtered on the usual small rotary Oliver vacuum filters. The muds are not reburned to recover lime, but at about 45 percent consistency are fed to a long rubber belt which automatically dumps into a large pile outside the mill. These muds are sold to the farmers for use on the land. No difficulty is experienced with silica build-up in the cooking liquors. The criticism of recovering chemicals in the cooking of plants such as straws, bagasse, reeds, and bamboo is based on the build-up of silica in the liquors, causing scaling in evaporators and causing other similar operating problems.

Dr. Joseph Atchison, in commenting on this operation, in one of his reports, attributes the success of "Phoenix" to the use of rye straw which has in that area a very low ash content. This is probably correct, but I am of the opinion that the practice of discarding the lime muds, and perhaps of evaporating much less than in the sulfate pulping of pulpwood, are fully as important factors.

After the mill visit we discussed in Mr. Wilkens' office the subject of bleached straw pulp, its quality, markets, uses, etc. Mr. Wilkens feels that there is now an over-production of bleached straw pulp in Europe. "Phoenix" pulp for years has been sold to paper mills in Europe and Norway and Sweden for blending with wood pulps to make high-grade and expensive papers. It is particularly noteworthy that Swedish paper mills have been using blends of straw pulp with their very strong wood pulps. "Phoenix" has not considered exporting to America because of the expense of setting up a sales organization. I was given several samples of papers made largely with "Phoenix" pulps. Mr. Wilkens was very much interested in the proposal made by Dr. Muller and myself for obtaining samples of his pulp for the purpose of joint tests. I had been told that Mr. Wilkens would be somewhat reticent about giving information but found that he answered my questions fully. He was extremely cordial to us.

<u>N.V. Carton and Papierfabriek v/h W. A. Scholtens (Scholtens Board and Paper Mills)</u>, Sappenmeer. Mr. D. G. Landweer, Managing Director, Mr. J. Prummel, Assistant Mill Manager.

Both Messrs. Landweer and Prummel speak perfect English. Mr. Landweer is one of the directors of Dr. Muller's experiment station, and headed the Netherlands MSA group of paper-mill executives and operators who visited Peoria and the TAPPI Fibrous Agricultural Residues Committee meeting held there in October 1952.

Scholtens was founded in 1878-9 and is one of the oldest of the paper mills using straw. Scholtens also originally produced starch from potatoes, but some years ago these two types of manufacturing interests separated.

The Scholtens mill is one of the largest (about 100 tons per day) and best operated of the Holland mills. The pulp mill building is a modern six-story concrete building housing the straw preparation, pulping and pulp preparation operations. The building was erected after the war to replace an old frame structure destroyed by fire.

The handling and pulping of straw by lime is much the same as at Erica II. Straw is chopped by the Nyblad cutter. Two men handle the 110-pound bales from the pile in the straw-storage shed, a part of the straw-preparation unit. These men remove the wires after the bale is placed on a rolling conveyor located about 6 inches above

the level of the concrete floor. The chopped straw is conveyed with a drag conveyer to the top of the digester house. The Nyblad cutter has a capacity of 4 to 5 tons straw per hour; knives are sharpened after every 8-hour shift. The cutter requires little maintenance.

Burned lime is slaked in a room at the top of the digester building and milk of lime and straw are run in separate streams directly into the 14-foot rotary digesters. Hydraulic rams are used for packing straw in the digesters but these have not proved satisfactory and are being replaced with the older type of mechanical rams. Straw is pulped for 3 to 4 hours with 10 percent of lime at 5 atmospheres (absolute). Pulp from the digesters is dropped to the floor below into large concrete chutes, one for each digester, and the straw at about 25 percent consistency is carried to Kollergangs by large screw devices. These screw conveyers are not showing the expected life and are being gradually replaced with those of much heavier construction. The concrete chutes also have somewhat more taper than desirable, causing some plugging by the wet pulp.

Straw is refined in the Kollergang for about 15 minutes and then in old-fashioned Hollander beaters for about 20 minutes. A freeness tester is of no use in controlling the refining of this lime-cooked unwashed pulp. The Kollergang has a capacity of about 1 ton (basis dry pulp) and uses about 30 hp.

The paper mill has four small old paper machines and two newer, larger machines. The machines make mostly heavy strawboard, but also 9-point board for wrapping. At the time of my visit 40-point board was being made, cut into sheets which were laminated in pairs, using sodium silicate, to make binder board for books and similar purposes. Three men were used in this operation. One passed the sheets through the machine which applied silicate solution to one side of the board. The others placed the wet sides of the sheets together in pairs forming a stack to fill a laminating press, such as is used in laying up veneer. The press load is placed in a tunnel dryer; after drying, the boards are trimmed to size individually. The laminated boards are 80 to 85 pt. in thickness.

One of the larger paper machines was not operating due to an industry agreement limiting the production of strawboard. The plant was operating on a 6-day per week schedule at the rate of 100 tons per day.

In addition to strawboard, a wrapping paper, entirely for export, was being made from waste paper on a large paper machine in a new part of the mill. The paper is continuously pulped in a breaker beater and from there is pumped to a Hydrafuge and two Hydrafiners manufactured by Shartle Brothers of Hamilton, Ohio. These machines had been in operation less than 1 year. The discharge outlet of the Hydrafuge was eroded through in 6 months' time and is entirely out of commission. The bars of the Hydrafiners are very badly eroded and one was out of operation entirely.

The waste paper is of the poorest quality I have ever seen, consisting of a mixture of every variety and is full of paper clips and dirt, largely sand. The paper on the paper-machine reel felt like sandpaper. The wear of the machines mentioned is due to the sand and other foreign materials. When asked my recommendations for correcting the situation, I advised them to install an old-fashioned riffler and sand trap. This illustrates the kind of problem an exporter of machinery runs into where conditions under which the machinery is to be used are not thoroughly understood. The paper machine, manufactured by Voith was running at 300 feet per minute and can run at 600 feet. It was equipped with rotary screens like those made by the Bird Machine Company and had a Yankee dryer installed in about the position where a size press operates. Due to the sand in the sheet, it was impossible to produce a water finish on the waste-paper sheet.

One of the most interesting features at this mill was the production of methane gas from the waste cooking liquor. This was pumped into the canal which ran beside the mill. Over an area of about 100 x 50 feet of the canal large steel bells about 10 x 20 feet were suspended so as to float to collect the methane gas as it formed. The gas is drawn off from the bells through a compressor at about 3 atmospheres and washed in water flowing down a tower filled with Raschig rings. This dissolves carbon dioxide, leaving about 4 to 5 percent remaining in the methane gas. The gas, which has a B.t.u. value about equal to coal on a weight basis, is pumped to a nearby water gas plant that purchases the methane. The rate of production varies with the season of the year.

The company has a very well-equipped office and research laboratory and a good pilot plant. In their paper-testing laboratory, in which humidity is controlled, the control instrument contains a strip of paper about 20 feet long stretched between electrical contacts. As the humidity changes in the room the paper becomes shorter or longer and opens or closes electrical circuits. This control mechanism is extremely sensitive.

Huize "Union," Oude-Pekela. Mr. J. Van der Veen, Assistant Manager.

This is the first company to commercialize the Northern Laboratory mechano-chemical process for pulping straw. About 2 years ago, young Mr. Van der Veen, the son of the mill manager, after reading our publication describing the process, decided to install it in their mill. He arranged with Black-Clawson International, the foreign sales representatives of Shartle Brothers, who manufacture the Hydrapulper, to install the process equipment. Neither B-C International nor Shartle Brothers advised us of this. Unfortunately, B-C International did not have a clear understanding of the process and several serious mistakes were made in the installation, such as providing an extraction plate instead of a solid plate in the pulper, supplying too small a motor. Mr. Van der Veen had considerable

trouble getting the process to operate but he corrected the mistakes gradually and is extremely well pleased with the process. He was a member of the MSA Netherlands group who visited Peoria in October 1952 and was very cordial when I called at his mill.

This mill, which is owned cooperatively by farmers, must accept every kind of straw offered. Oat straw makes a weaker strawboard than either rye or wheat straw. Because the mechano-chemical process produces a higher quality board than the conventional lime-pressure pulping process, the new method is used only to cook oat straw.

Straw is chopped with a Nyblad chopper and is blown both to the pressure digester house and to the Hydrapulper bin.

The process of cooking wheat and rye straw using lime under pressure is the same as described for the other mills using Kollergangs and Hollanders. Two of the paper machines convert this lime-cooked pulp into rather heavy strawboard of the general type used for corrugating and liner board. These paper machines run at low speed. The third machine operates entirely on mechano-chemical pulp to which is added 35 percent waste paper pulp. This machine is more modern, is supplied with modern screens and jordans, and makes a good sheet of corrugating board and wrapping.

The mill is integrated with a boxmaking plant where shipping containers are made and printed. The strawboard made by the mechano-chemical process is of a lighter color than that of lime-cooked straw, is converted into special containers for which a higher price is obtained, and shipped to a customer in Western Germany. Sodium silicate is used as an adhesive since potato starch is too expensive.

The details of the mechano-chemical process operation follow:

The Hydrapulper of 11-foot diameter is provided with a cover having a small opening, closed by a door, through which the action of pulping can be seen or samples obtained. The Hydrapulper now has a 110-hp. motor, but draws only 75 hp. during the pulping operation. The rotor is 66" in diameter and the plate solid. The draw-off line is 12" in diameter to which is attached a 6" centrifugal pump with motor. The Hydrapulper is charged with 900 kg. straw in 10 minutes by blowing from a cyclone. Before the straw addition, the Hydrapulper is charged with 9 cu. meters of a chemical solution consisting of 50 kg. lime (CaO) and 50 kg. sodium carbonate heated in an outside tank to 95° C. The cooking cycle is 1 hour (10 percent consistency) at 98° C., the temperature being maintained by the introduction of a small amount of live steam. Mr. Van der Veen says that the friction generated during pulping supplies almost all the heat required. A sample of pulp is examined by diluting in a glass with water to estimate the exact time to continue cooking. At end of cooking, the dump valve is opened and the pulp is pumped out of the pulper in

3 minutes. This pulp at a yield of 75 percent based on straw is diluted to about 5 percent consistency in the stock chest and is pumped from there to the paper machine after mixing with the waste paper pulp.

The cook operating the pulper stated that he now could tell when the pulping is finished merely by the appearance of the pulp in the Hydrapulper. Mr. Van der Veen said that the pulping can easily be made a push-button operation. The pulp is not washed but consideration is being given to installing a washing system. Mr. Van der Veen carries on experiments over weekends. Mr. Van der Veen thinks that the straw pulp made by the new method is freer and runs faster on the machine than the lime-cooked pulp. He also thinks that the quality of the board is superior, but has no method for measuring stiffness. I told him that we would be interested in receiving samples from him, and would let him have the results of our tests. These samples have been received. In this way we will keep in touch with this company. We understand that consideration is being given to installing a second Hydrapulper. Mr. Van der Veen is allowing visitors to see this operation since it is running smoothly.

The operation of our process at this mill has met our expectations of simplicity of operation and control, yield, and quality of product.

<u>Nederlands Proefstation voor Stroverwerking</u>, Groningen. Dr. F. Muller, Director, Mr. P. M. Smolders, Assistant to Dr. Muller.

This experiment station has a budget of about $100,000 which, because of the much lower salaries and other costs in the Netherlands, provides for a larger staff than such a budget would permit in the United States. The station is supported mainly by the government but also by industry and other organizations. The over-all administration is by a board of directors. As noted earlier, this station cooperates closely with the paper division of the Vezelinstituut at Delft.

The station is located on the grounds of the Electric Company Power Plant just outside of Groningen, which is a city almost the same size as Peoria. Two buildings, separated from each other about one-half city block, are occupied. The first which we visited was that housing the pilot-plant equipment and the engineering office. The building, one story high, is well adapted for this work. One of the rooms is being remodeled for locating in it an experimental paper machine.

Pilot-plant equipment consists of a rotary digester of about 100-liter capacity capable of operation at high pressures but not supplied with a blow line or tank. A 3-foot Hydrapulper which is arranged for heating with a jacket is installed. International, who built the Hydrapulper, supplied a perforated plate instead of a solid plate with too small a motor, only 15 hp. They sent an

erection drawing for a concrete base and then changed the design of the Hydrapulper legs without notifying Dr. Muller. Dr. Muller is very much interested in the mechano-chemical process.

A small "conical" refiner, resembling a small jordan, is connected to the Hydrapulper and tanks to study refining. This refiner is provided with weights so that definite pressures may be applied to the conical plug during refining. A small Kollergang completes the refining equipment. The pilot plant is not provided with a beater. Interest has developed in the effect of fibers of various lengths and a fiber-fractionating machine for separating pulps into four fractions has been built. This consists of a set of three large vertical concentric screens.

A small chipper and a hammer mill were being used to prepare poplar wood for some pulping experiments. Consideration is given to the use of high-yield semichemical poplar pulp in newsprint or other paper manufacture.

A small but adequate machine shop is housed in the pilot-plant building.

The most ambitious project at present is the building of a paper machine, of a width of about 18", which will be suitable for making paper or board in weights from 100 to 600 grams/square meter. This machine is of the station's own design and is being built for them; the delivery is expected by this summer.

The cost of this machine, exclusive of headbox, calender stack, and piping, but with dryers, is $35,000. Dr. Muller estimates that the machine can be erected, and the headbox and piping can be installed using their own crew and facilities for another $3,000.

I was given confidential information on two interesting projects for which patents are being applied. One of these is concerned with a new and simple method of washing pulps. This is very badly needed by the strawboard mills in Holland. As I have mentioned previously, with few exceptions, board pulps made from straw receive no washing. The other project deals with cooking straw with sodium sulfite alone, using no alkaline buffer. The pH is not allowed to drop below 5.0. It is thought that the straw acts as an ion-exchanger, preventing the presence of free H-ions, so that the pulp is not damaged. The pulp comes from the digester looking like the original chopped straw but is broken into pulp with a small amount of refining and is suitable for board pulp. The process cannot be used for producing bleachable fine pulp but requires soda ash addition if this is the goal. This latter confirms the Northern Laboratory findings for fine pulp manufacture.

The remainder of the station is located in one of the smaller buildings of the Electric Company. The administration offices, library, and laboratories are located on the second floor, and on the first is a large testing laboratory controlled at 65 percent relative humidity at 20° C.

The chemical laboratory is large. Here all the analytical work and pulp bleaching is conducted. Electricity is used for heating except for certain special purposes for which bottled gas is used.

In another large laboratory, pulping, pulp washing, screening, fractionation, beating, and sheet-making equipment is installed. Two small, about 2-4 liter, electrically heated autoclaves, not provided with blow lines, are used for small-scale pulping studies. The pulp washing, screening, fractionating, and sheet-making apparatus is of Swedish make. The Jocro mill, which is used to develop pulp strength, is not of the standard design but use of a smooth rotating plug acting against a smooth surface instead of the standard serrated plug has been found to develop higher strength in straw pulps. A TAPPI beater of Swedish make is installed but I gained the impression that it had been used very little.

Considerable work is under way in fractionating pulps after different degrees of beating and making handsheets from these fractions. Dr. Muller expects to publish the results of these studies along with the Jocro mill data. The Northern Laboratory has conducted some interesting tests with fractionated straw pulp. More fundamental studies of this sort are badly needed.

For such a small research group, the library is quite large. Dr. Muller was trained as a botanist and his interest is still along botanical lines. The biochemical laboratory has purchased an excellent projector for their microscope. The projector is very compact, giving a field about 8" in diameter. The projector is of Italian make and manufactured by Laboratorio Costruzione e Richerche, Via del Carmine 29, Torino, Italy.

In a discussion of the Northern Laboratory work, Mr. Smolders stated that the reported requirements of steam in mechano-chemical pulping appeared to be less than that required to heat the water alone. I called his attention to our finding of temperature increase due to friction of the fibrous material in the Hydrapulper and to the heat available in the reused cooking liquor. I said that we would recheck our results at Peoria to satisfy ourselves that the results of the Noblesville test reported by Krancher of the Noblesville mill were in line. We have confirmed these results and have written to Dr. Muller. In Europe, and particularly Holland, steam and power costs are high as compared with labor costs.

N.V. Cartonfabriek Beukema and Company, Hoogezand. Dr. T. R. Beukema, Director, Mr. R. Hellemans, Sub-Manager.

This company is one of the most progressive in Holland. Both Dr. Beukema and Mr. Hellemans have visited Peoria, the former with the ECA team and the latter with the MSA group last October. Mr. Hellemans also had operating experience in Java in making fine paper from rice straw.

Four different processes are used for pulping straw. The oldest of these is the lime process--cooking for 3-1/2 hours at 40 p.s.i. with 8 percent CaO on straw. The pulp is treated in the Kollergang and beater but not washed. Yield of pulp is 75 to 80 percent. More recently some of the pulp is cooked in rotaries for 3-1/2 hours at 25 p.s.i. with 6 percent NaOH on straw. The pulp is treated in the Kollergang and beater, is washed, and is then sized and dyed in a beater. Yield is 60 percent based on straw. A third process consists in cooking straw in rotaries for 3-1/2 hours at 45 p.s.i. with 10 percent Na_2SO_3 and 1 percent NaOH. The pulp is treated in the Kollergang and beater and is washed. Yield of pulp is 52 percent. The fourth process is a modification of the third process. Straw is cooked in rotaries for 3 hours at 45 p.s.i. with 7 percent Na_2SO_3. The pulp is treated in the Kollergang and beater but is not washed.

All of these pulps are used on Fourdrinier machines to make a very wide range of specialty board products. Straw paper of weight 180 grams/square meter is used for corrugating. Most of the other board products are lined on one or both sides with different lining papers, such as kraft paper, wood-free white paper, wood pulp white paper, sulfite papers, etc. Dr. Beukema has sent a set of samples of some of these products to Peoria since my return, on which we expect to make physical tests.

Mr. Hellemans prefers the use of caustic soda to neutral sulfite for cooking because the digesters are not suited for more than 45 p.s.i., which is required by the neutral sulfite process while only 25 p.s.i. is required for the soda cook. In Java at the Surabaya rice paper mill the straw was cooked with 7 percent caustic. The spent cooking liquors were mixed with the waste bleach liquors to neutralize the caustic and this mixture was highly prized as irrigation water on the rice fields.

N.V. Noordelijke Industrie voor Vezelverwerking, Hoogezand. Mr. Smit, Chairman of Board of Directors, Mr. H. t'Hooft, Technical Manager, Mr. K. R. Bes, Technical Superintendent, Dr. T. R. Beukema, Member of Board of Directors.

Dr. Beukema accompanied me on this visit since his mill and the wall-board company mill are located within easy walking distance of each other. Mr. H. t'Hooft, who was one of the MSA team at the Laboratory

in October 1952, was ill and I did not see him. Mr. Smit, who speaks good English, received me and Mr. Bes, who also speaks good English and who formerly was assistant to Dr. Muller of the Straw Experiment Station, showed me through the operation.

I was extremely interested in seeing this plant since it is the only one in the world using straw to manufacture insulation (soft) board and hard panel board products. The process was worked out by Dr. E. L. Ritman, formerly director of the Netherlands Straw Experiment Station. The process is largely based on the developments of the Asplund Defibrator Company of Sweden but certain modifications were necessary to adapt straw to this process. We had had some knowledge of this development since Mr. Harold Hay, for some years a member of the Agricultural Residues Division staff, was employed in Sweden by Asplund and carried on a good share of this development work with Dr. Ritman.

Although the process was very largely perfected before the war, it was not possible to build the plant until after 1946. Many difficulties were experienced in starting up the plant and particularly in producing products of high enough quality to compete in the world market. Most of these difficulties have received more or less satisfactory solution. From the business angle, price competition with mills in Sweden and Finland has also been a problem, but at the time of my visit it was felt that the industry was in good condition. About half of the production of the company is being exported.

The cost of the plant and buildings, all of brick construction, was said to be $1,750,000. The annual production of hardboard is 13,000 long tons and of soft board 9,000 tons. Soft insulation board 1/2" thick and hard panel board 1/8" thick each weigh approximately 700 pounds/1,000 square feet. The daily production of soft board is about 100,000 square feet and of hard panel board 130,000 square feet.

The first step in the process for making either soft or hard boards is straw chopping and cleaning. This system is extremely elaborate and in the opinion of Mr. Bes is needlessly complicated. Certainly a system of this sort would not be installed in the United States. The straw is chopped to about 1" in length by the Nyblad chopper and is then blown into a cyclone to remove loose fines and then through a rotary screen to remove heavy dirt. The straw is then passed over magnets to remove tramp iron and passed into another cyclone, the accepted straw passing out the top and the nodes and heavy particles falling out from the bottom of the cyclone. The accepted straw is then distributed to separate bins for each system. These bins, made of concrete, hold sufficient straw for some hours' production. The conveying systems to and from these bins is complicated and provides means for a certain amount of intermixing of the straw so as to compensate for irregularities in straw quality.

For the manufacture of soft board, the straw is wetted in a mixer with a solution of caustic soda to provide 3 percent NaOH, on the basis of straw used, and then the mass is fed into 36" Asplund defibrators which are operated under a temperature of 183° C. by the injection of high-pressure steam. The straw and caustic are in the Asplund about 10 seconds and the pulp is discharged continuously through Asplund pumps into blow tanks. The pulp from the blow tanks is pumped over deckers for thickening and from there to the board machine pulp chest. Deckering the pulp removes a certain amount of dirt and fine fibers.

The pulp from the deckers has a pH of 6.0 to 6.5 and on the way to the machine chest is treated continuously with rosin size and sulfuric acid to bring the pH to 4.5. Mr. Bes claims that they obtain better waterproofing with the use of H_2SO_4 than with alum. I am doubtful of this.

The first trouble in starting manufacture was in feeding straw to the Asplunds. This was finally solved by chopping the straw finer and by mechanical changes made by the Asplund Defibrator Company in the feeding devices. The quality of the board made originally without any treatment of straw with caustic soda was unsatisfactory because of lack of physical strength. This was first corrected by the addition of either repulped waste paper or purchased mechanical pulp. After reading the publications of the Northern Laboratory on the manufacture of insulating board from straw, Mr. Bes decided to try pulping the straw in the presence of a small amount of caustic soda and finally hit on the use of 3 percent empirically. He is not at all satisfied with this method of operation and desires to use a hydrated straw pulp such as is made for strawboard use as recommended by the Northern Laboratory. He recognizes that his present method lacks good control features and does not permit manufacture of boards of varying controlled physical characteristics. The pulp is held in the Asplund defibrator too short a time to do a good job of cooking or hydrating.

The pulp from the machine chest is pumped to a Fourdrinier-forming machine which produces a board 8 feet wide. After passing through a series of baby and then heavy press rolls, the board is cut with saws into sheets generally 8 x 12 feet, which are fed into a multiple deck dryer, like a Coe dryer. The boards from the dryer pass, by immersion between rolls, through a small water bath in order to provide sufficient moisture for seasoning the board to a moisture content of about 10 percent. This operation is not satisfactory since not enough water remains on the board to raise the board to the required moisture content. Mr. Bes, knowing my experience in insulating board manufacture, asked for suggestions. I suggested that a second wetting device be installed and that the present device be moved towards the saws as far as possible from the dryer. I thought too much water was evaporating due to the heat held in the board. I also suggested that rotating knives instead of saws

be used for cutting and trimming the board. This is the practice in the United States. The dust and explosion hazard is greatly reduced and a much more acceptable cut edge is produced using rotating knives.

For interior decorative use, it is desirable for the board to have a white smooth surface. This is accomplished by the use of a secondary headbox located over the board between the baby and heavy presses. This headbox is placed about 24" above the surface of the board, extends the full width of the board, and is about 2 feet wide. A thin slurry, about 1 percent, of bleached mechanical pulp, is pumped to the headbox and overflows in a uniform stream onto the board. The water drains into the board leaving a thin layer of white pulp bonded to its surface. The board then passes through the heavy presses where the added water is extracted and the board is dried. At first, clay was used instead of the bleached pulp, but the clay rubbed off and the surface was not so satisfactory. The physical strength and heat insulation value of the soft board as advertised are most satisfactory. The appearance, feel, and handleability of the board are good.

Mr. Bes is greatly impressed with the Northern Laboratory fundamental work on insulating board manufacture from straw and would like to improve the physical properties of the soft board. To do so he desires to incorporate a certain percentage of long fibers, e.g., 3/4+". To date he has found no way to do this with the Asplunds. He has built for laboratory work a fiber fractionator (Northern Laboratory design) so as to determine the fiber length characteristics of regular production and to prepare fractions for laboratory development studies.

In the manufacture of hard panel board, the straw is wetted with water only before being fed to the Asplund defibrators. No caustic is used. The Asplund pulp is deckered and formed into a board on a Fourdrinier machine similar to that used for soft board. Water-soluble phenolic resins are added to obtain satisfactory strength. I was not informed of the amount. For part of the production, a surface of bleached mechanical pulp is applied to the upper surface in the same fashion as described for soft board. The boards after passage through the heavy press rolls are cut into sheets 8 x 18 feet and fed into a rack with 20 daylight openings. Each of the boards rests in the rack on wire screen over rollers. The rack is fed by the standard automatic tipple feeder used in hardboard mills. When the rack is full and the 20 platen hydraulic press empty, the entire load is rolled into the press. The board is pressed for 10 minutes under 55 atmospheres absolute pressure at 200° C. In the pressing cycle the press is first closed for 1 minute and is then slightly opened for 8 minutes to allow for escape of steam and is closed for 1 minute at the end of the cycle. The board is then discharged from the press into a rack from which it is discharged down a ramp for inspection. The screens are conveyed back automatically to the loading ramp.

After inspection of the pressed boards for surface appearance and other imperfections, the boards are seasoned. The seasoning operation is similar to that developed in Sweden for hard board made from pulpwood. The boards are placed on a conveyer which holds the boards on edge with the long axis of the board horizontal. The seasoning chamber is a very large brick structure, devoid of compartments, through which the boards are slowly conveyed. In the first part of this chamber the board is heated for 3 hours to 170°-172° C.; in a second it is cooled for 1 hour to 80°-100° C. and finally is conditioned with humidified air at 95 percent R.H. and room temperature for 5 to 6 hours. When so conditioned the hardboard contains 4 to 5 percent moisture. The boards are automatically turned 90° as they come out of the seasoning chamber so that they are placed on their flat surfaces. After another inspection the conditioned hardboard is sawed to size and packaged.

Considerable difficulty is experienced in obtaining uniformly acceptable surfaces on the hardboard. Mr. Bes attributes this to the fact that the board does not dry in the press absolutely uniformly and that there are spots which contain some steam when the platen of the press is raised at the end of the pressing cycle. From my experience in developing hardboard from sugarcane bagasse, I suggested that nonuniformity of formation on the board machine and nonuniformity of the drainage characteristics of the straw pulp might be responsible.

The company has solved many of its operating problems and their products are gaining in trade acceptance. Mr. Smit stated that in spite of the price competition of Swedish hardboard the costs of production were now favorable to the Holland products.

The subject of fireproofing and termite resistance has received some attention. In connection with a contract with the U. S. Air Force in Germany, a fireproofing treatment involving application of ammonium phosphate solution has been used. The testing and control of operating variables appears to be good. A well-equipped control and research laboratory showed evidence of a good deal of activity. All in all I was most favorably impressed with the whole operation and management. I am convinced that the Northern Laboratory process is superior to that at Hoogezand. In addition, it seems clear that the fundamentals of producing fibers from straw or bagasse for hardboard manufacture are not understood. Mr. Bes writes that he has shipped us a set of 12" x 12" samples of their boards for tests and exhibit purposes.

<u>N.V. "Sove" Bleached Straw Factory of Algemene Kunstzijde Unie N.V. (A.K.U.)</u>, Kleefsewaard, near Arnhem. Dr. J. van Dantzig, General Manager, Dr. P. H. Teunissen, Director of Production, Dr. E. Schonberg, Laboratory and Pilot-Plant Director.

In an article by Dr. Joseph E. Atchison, Chief, Pulp and Paper Branch, Mutual Security Agency, entitled "Straw Pulping Developments in the Netherlands" appearing in INDIAN PULP AND PAPER, Anniversary Number, Vol. VII, No. 1, July 1952, p. 36-43, he discusses the production of

bleached straw pulp and the programs for expanding its production in 1951. Particular attention is given to the proposed "Sove" mill which was then being constructed. At the time of my visit the mill was in full operation.

A.K.U. is one of the leading rayon companies in Europe. During the German occupation because of a shortage of wood pulp and a need for more rayon manufacture, the Germans directed A.K.U. to build a mill for the manufacture of rayon alpha-cellulose pulp from straw. A process had already been developed by Waldhof (still said to be operating under Russian supervision in East Germany) which consists in prehydrolysis followed by sulfate-process pulping of the prehydrolyzed straw. The over-all yield of alpha pulp was in the neighborhood of 25 percent. It was expected that yeast would be grown on the prehydrolysis waste liquor using a method also developed by Waldhof. Both the pulping and yeast-production process were reported by our investigation teams after the war, and a movie showing the construction of the Waldhof straw alpha-cellulose mill was shown at the Northern Laboratory a few years ago.

I was much interested in visiting this mill. In Rome I learned that Dr. Muller had not seen the mill and through the offices of Dr. G. Consiglio, a director of CELDECOR, we both received an invitation from the home office of CELDECOR in England to visit "Sove." Dr. Muller, accompanied by Mr. Smolders, drove me from Groningen to Arnhem, a distance of about 75 miles. The "Sove" plant is located on the property of the large rayon plant of A.K.U. situated on the North Bank of the Rhine just outside of Arnhem. "Sove" obtains its steam, electricity, transportation, and chemicals from the A.K.U. plant.

Dr. Atchison describes the very complete pilot plant of "Sove." I did not have an opportunity to see this plant since it was necessary for me to leave early in the afternoon for Amsterdam and I desired to make a very careful study of the CELDECOR process. The CELDECOR people said that of all the plants which they had built "Sove" was the most modern and the first fully equipped with the machinery and controls for the complete process.

By the time Germany surrendered, the building to house the alpha-cellulose straw plant had not been completed. After the war A.K.U. proceeded first to make a complete pilot-plant investigation of the Waldhof process of prehydrolysis and sulfate pulping. It is my understanding that while a satisfactory pulp for staple rayon fiber manufacture could be made, that the yields of 25 percent and the operating costs directed the attention of the A.K.U. management to the possibilities of making bleached straw pulp for paper manufacture, since yields of 40 percent or better might be obtained. Already the Phoenix mill was making bleached straw pulp by the sulfate method and Eendracht was exploring the neutral sulfite process for making bleached straw pulp.

Because of the large electrolytic plant of A.K.U. for producing cheap caustic soda and chlorine, the CELDECOR process was regarded with favor. While pressure methods of pulping straw were thoroughly explored, a study of the CELDECOR process was made in the English pilot plant, and a CELDECOR pilot plant with a 25-foot high caustic digesting tower was then built at A.K.U. In addition, arrangements were made to carry out each step of the CELDECOR process batchwise. Based on this thorough work, the CELDECOR process was decided on and a plant with a capacity of 42 metric tons per day was built by CELDECOR.

The process is discussed here at some length because more plants are producing bleached straw or bagasse pulps by its use than by any other process. The process has filled a real need in the past 25 years in that it has made possible the establishment of small paper mills in various underdeveloped countries that possessed no chemical industry. The process depends on the joint and complete use of caustic soda and chlorine for pulping and bleaching as they are produced. Furthermore, the weak caustic and wet chlorine are used in the concentration, condition, and stoichiometric relation in which they leave the electrolytic cell. The only chemical raw materials necessary, therefore, are the agricultural residue and salt. The process is continuous and CELDECOR has not only developed special machinery for each step in the process but contracts to construct the pulp and paper mill and to instruct operating personnel. Continuous processes are the vogue today and this feature appears to be attractive to prospective mill owners.

The quality of the CELDECOR process pulp has been under question many times. It has been stated by people having extensive experience as operators of the process that yields are not uniform and that the bleached pulps tend to make brittle and weak papers. This has been attributed to the use of too much chlorine and particularly the use of chlorine as a pulping rather than as a bleaching agent.

The experience in operating the process at "Sove," I believe, exposes its essential weakness, which lies in caustic digestion tower control. Further, it demonstrates that, even in spite of careful and thorough pilot-plant investigations, actual operating conditions on a full-scale plant may not be duplicated and perhaps wrong decisions may result even with the best available data.

After a discussion with Drs. Dantzig and Teunissen of our interest in visiting the European straw pulp mills and of the interest of certain fine paper mills in the United States in bleached straw pulps, Dr. Teunissen conducted us through the plant and gave a thorough discussion of each operating step. All of our questions were answered fully.

The building housing the pulp mill is of concrete and brick construction, 6 stories high. The construction is ponderous, the concrete floors being about 1 foot thick. Only about half of the building is

used presently so that room is available for increasing production 100 percent. The reason for the very heavy construction of the building was said to be that large supplies of cement and brick had been brought to the Holland border for the "West Wall" and the Germans decided to use up some of this oversupply. The building had been laid out for the installation of large rotary digesters and a great many building changes had to be made to install the CELDECOR machinery.

The "Sove" plant is owned and financed 60 percent by A.K.U. and 40 percent by the Netherlands Government. Future plant expansion will depend not only on the ability of "Sove" to sell its production at a profit, but also on the future availability of straw. Arnhem is about 70 miles south of the major wheat-growing area.

A season's requirement for straw is stored in large brick warehouses on the A.K.U. fenced-in plant site but about 1 mile from the pulp mill. This baled straw is carried by A.K.U.'s narrow gauge railroad to a large intermediate warehouse (1 week's storage) and straw-cleaning building outside the pulp mill.

The straw-cleaning system is elaborate. Straw is chopped by the Nyblad machines and is passed through cylindrical screens not only to remove dirt and wheat grains but also nodes. The straw is blown to a cyclone and bin on top of the digester tower building. It is automatically fed into a mixer where it is thoroughly wetted with a 3-percent caustic soda solution and from there the straw and caustic is fed into the top of the single digestion tower.

This is the largest digestion tower that CELDECOR has built. It is 75 feet high, 6 feet internal diameter for a length of about 55 feet, after which it is about 10 feet in diameter for the remaining 20 feet at the bottom. Pulping proper takes place in the 6-foot diameter portion of the tower, which is jacketed for heating with steam in sections of about 10 feet in length. The straw enters the top of the tower at a 4 to 1 liquids-solids ratio. Near the top of the tower live steam is injected into the straw to bring it to boiling temperature. As the straw reaches the end of the 6-foot diameter section, its temperature is about 125° C. corresponding to a gauge pressure of about 20 p.s.i.

Near the bottom of the 10-foot diameter section, provision is made for the introduction of water and a stirrer is located in the bottom of this section. Pipe lines are provided for pumping the pulp slurry out of the bottom section of the tower. The large diameter of this section is to provide room for diluting the pulp from about 25 percent to 3.5 or 4 percent consistency. The time of passage of straw through the tower varies between 6 to 7 hours. Rye straw takes a little less time to cook than wheat straw. About two-thirds to three-fourths of the total time is spent in the 6-foot diameter section of the tower. The pH of the pulp at the bottom of the tower is 13 to 14 and there is no free alkali.

The large size of the tower caused a great deal of difficulty in securing operating control. Dr. Teunissen had to personally work out the operation of the tower and teach the digester-tower operators. This operation technique had to be learned as an art rather than a science.

I feel sure that the real weakness of the continuous cooking process came to light in the operation of this large tower. In the de la Seine mill I noted that the straw was not uniformly cooked when it came from the digestion tower, and this same fact had not only been stated by other observers but was also most evident in the CELDECOR pilot-plant operation in Kent and in the two towers operated in the Bowater's plant at Sittingbourne, England.

Dr. Teunissen said that the difficulty in controlling the operation of the "Sove" digestion tower had its source in the injection of the colder dilution water at the bottom of the tower. If too much water is used, the tower overflows at the top, and if too little water is used the pulp is not diluted enough in the lower section to be removed from the tower. It is evident that control between these two extremes is difficult. It is obvious that in adding water to the bottom of the tower where the water is considerably colder than the pulp, uniform mixing and temperature equilibrium will be most difficult to attain and maintain and that if this is not maintained channeling will take place. Under these conditions circulation of cold and hot streams will be set up in the same fashion as by a heat pump. Cold water will tend to rise in the tower, materially changing the temperature in areas, resulting in undercooked straw in these areas and in overcooked straw in other areas. This mechanical defect accounts for the nonuniformity of pulping noted.

When we reached the operating floor of the digester, a large part of the floor space was covered with screenings, consisting of partially cooked straw pieces. These were being fed back into the digestion tower. Dr. Teunissen said that some trouble was still being experienced in controlling the digestion operation. Later when we saw the screening operation, we found an extra crew using rakes to keep the Jonsson screens clear. The screens were overflowing with rejects which were raked into small wagons for return to the digester. As will be noted, these rejects had already passed through the chlorination and secondary alkali treatment towers and still were not pulped.

In order to control digestion-tower operation, the minimum amount of water is added to the tower and more water is added in the pipe line leading from the digester in order to lower the consistency so that the pulp can be pumped back to the digester operating floor, a head of about 80 feet.

The pulp at about 3.5 to 4 percent consistency is passed over a vacuum washer to remove cooking liquor, from which the pulp at perhaps 15 percent consistency passes into two screw presses from which

it emerges at 27 to 28 percent consistency. These presses gave trouble in plugging and Dr. Teunissen thought the design of the French presses (Papeteries de Marie) were better. The operators at Bowaters also had trouble with the CELDECOR presses. The pulp at this point contains many pieces of undigested straw culms and nodes. An examination of the nodes showed that the pressing did not break them down mechanically.

The pulp from the presses is fed by screw conveyers into two machines called "openers" in which interlocking, rotating "pickers" tear the lumps of fiber apart. The purpose of the opener is to break up all lumps formed in pressing and to produce a porous pulp mass into which chlorine gas can uniformly penetrate. The openers at "Sove" were not performing as satisfactorily as those at the English CELDECOR pilot plant. The pellets obtained at "Sove" are larger, so that the chlorination step does not operate as smoothly as hoped.

From the openers, opened pulp is fed by gravity into two chlorinators. Each chlorinator is composed of 3 parallel towers made of glazed tile about 18" internal diameter and about 25 to 30 feet high. The amount of chlorine and the pressure of chlorine fed to each tower is under rigid automatic control. Each tower is provided with several sight glasses at different levels so that visual inspection may be made of the color changes in the pulp mass as it progresses down the tower. This is a part of the operating control of the tower.

The temperature in the tower rises about 8° to 10° C. due to the exothermic action of pulp and chlorine, but the temperature of the pulp is maintained below 30° C. The chlorinated pulp falls by gravity into cold water. Five to 6 percent of chlorine based on the dry weight of the pulp is used, and about 25 percent of this chlorine is converted into hydrochloric acid. Chlorine is introduced at several levels through pipes in the periphery and also through a pipe line running in the center of the towers. Chlorine at this point is used as a pulping and not as a bleaching agent.

The pulp is diluted with cold water to a consistency of 1 to 1.5 percent and is pumped to a rubber-lined vacuum filter fitted with stainless-steel wire (18 Ni - 8 Co - 4 Mo).

From the filter the pulp at about 10 to 15 percent consistency is carried by a screw conveyer to the top of a concrete tower where it is introduced along with a stream of dilute caustic soda to neutralize the pulp and extract chlorinated lignin compounds. The pulps react with the caustic in the tower from 2 to 3 hours at about 4 percent consistency. At the bottom of the tower a Bellmer agitator keeps the slurry circulating.

A pump, with the addition of water, moves the slurry to a vacuum filter. The pulp from this filter is diluted with water to about 1 percent consistency and is pumped to a battery of Jonsson screens, the

screen plates having 3-mm. holes. The accepted pulp at 0.8 percent consistency goes to CELDECOR centrifugal screens having plates with holes 0.8 mm. From there the accepted pulp is pumped through a battery of "Dirtec" cleaners at about 0.3 percent consistency. The rejects from the Dirtecs are discarded, and those from the screens are returned to the continuous digester, except on one day of each week. I was told that the screening system was quite satisfactory and that the centrifugal screens did a particularly good job.

The pulp from the "Dirtec" cleaners is thickened over deckers. This pulp has a brightness of about 65. By squeezing this pulp in my hand, it appeared to be "slow" as compared with mechano-chemical straw pulp. The filtrate from the deckers, which Dr. Teunissen said does not contain much fiber, is stored in a large chest which overflows to the sewer. This water retained in the chest is used as dilution water. I called attention to the fact that this white water contained the fine fibers from the nodes and other elements of the straw, and while these fibers added somewhat to the yield figures they produced a slow pulp which would slow down the paper-machine operation. I suggested that an examination be made of the effluent to see if it did contain mostly the very fine fibers, in which case the water might be discarded, or if a shortage of water existed, it might be filtered before using.

The deckered pulp is bleached in two stages. The first stage is carried out in concrete towers at 30° C. and 4 percent consistency for 4 hours using chlorine gas to satisfy 90 percent of the chlorine requirements of the pulp. This amounts to about 3 percent chlorine, based on original straw, or about 6+ percent chlorine based on pulp. The pulp has a brightness of about 80.

The pulp from the towers is diluted, washed over vacuum filters, and bleached batchwise in Bellmer bleachers at about 3.5 percent consistency. Sodium hypochlorite is used under close laboratory control to a brightness of 86. The bleaching action is stopped by the use of SO_2, after which the pulp is washed over vacuum filters, is diluted in the paper-machine test, and pumped to the paper machine.

The paper machine is of German make and uses cylinder dryers. This machine was delivered in 1943. Dr. Teunissen agrees that an air dryer would be preferable. The pulp sheet is dried to about 18 percent moisture to avoid case hardening. The dried pulp board is cut into sheets at the end of the machine and the sheets are packed into 200-kg. bales. A sample representative of every bale made is taken across the machine width and complete physical tests are made on the sample. So far, no complaints on moisture have been received.

The yield of pulp is said to be 45 percent, but I think this is doubtful. From what I saw and have heard, I believe the yield would be closer to 42 percent.

The production capacity of the mill is rated at 40 tons but this production rate has not yet been reached. It was stated that 25 operators were used on each 8-hour shift with an additional 20 men on the day shift to transport and handle straw and baled pulp. The probable cost of the mill at present prices was estimated by Dr. Teunissen at $2,800,000 or $70,000 per daily ton of bleached pulp.

The plant is extremely well engineered and the housekeeping is excellent. The vacuum filters, washers, and centrifugal screens used in the CELDECOR process seem to be excellent and are highly thought of by other paper and pulp-mill engineers. The plant is provided with many control instruments and each stage of operations has its own instrument control panel from which all machinery in that stage can be started or stopped. For example: The process from feeding straw to the digestion tower through the first washing stage is controlled by one man on the digester operating floor; in turn, chlorination and washing, screening and deckering, and bleaching were controlled from successively centrally located panels.

Dr. Teunissen said that their experimental work on the production of an alpha-pulp from straw by prehydrolysis followed by sulfate pulping gave a pulp with 98 percent alpha-cellulose, and 0.3 percent ash content at 23-percent yield based on straw.

Dr. Atchison, in his discussion of the bleached straw-pulp industry in the Netherlands, remarked that the mills have found that the nodes may be repulped without damaging the character of the pulp and with a consequent increase in yield. This subject has been referred to before. I discussed this subject, and the possible use of "Sove" pulp in America. Dr. Muller and I arranged to obtain samples of pulp for test and these samples have been shipped to us. We were told that some samples of "Sove" pulp had been tried in paper-mill runs by American mills with both good and poor results. One mill reported that the pulp contained "fish-eyes" which caused small "windows" in the finished paper due to "picking" of the lumps on the calender stack.

Since my return, Dr. Teunissen has written me that their pulp, ready for the paper machine, e.g., not beaten, has a freeness of 33°-35° S.-R. and that their dried pulp has a freeness of 27°-28° S.-R. He states that neutral sulfite, machine-dried straw pulp made in Holland has a freeness of 26° S.-R. The Northern Laboratory neutral sulfite undried pulp has a freeness of 20° S.-R. and the mechano-chemical pulp 23°-25° S.-R. The freer pulp made by the Northern Laboratory is due to removal of node material. This shows the difference between European and American viewpoint in paper-mill operation. Dr. Atchison evidently did not analyze this situation fully.

ENGLAND

January 7-14, 1953:

Lyddon and Company, Ltd., 35 New Bridge Street, London, E.C. 4. Mr. M. F. Reid, Mr. W. Acton, Mr. C. W. Aylen, Directors, Mr. W. H. Stanley, Sales Engineer, Dr. Julius Grant, Consultant.

This company, which has New York offices, is associated with Parsons and Whittemore, Inc. of New York and with Millspaugh, Ltd., of Sheffield, England. For many years Lyddon has been an exporter and importer of paper pulps. Since the war, due to their familiarity with the paper situation in many countries, they have become interested in selling pulp and paper-mill machinery and in constructing mills. In turn, they might act as pulp or paper sales agents for new mills. They have become interested in the use of certain tropical woods, particularly eucalyptus and in cereal straws, esparto, and sugarcane bagasse, as well as other annual fibers. For example, they have built a mill in Costa Rica to pulp abaca waste and one in Brazil to pulp eucalyptus wood. Because of this interest, their representatives, Messrs. Reid and Acton and Dr. Grant have all visited the Northern Laboratory. Dr. Grant, one of the leading British paper and pulp experts, spent two days in Peoria. This company was kind enough to arrange all of my visits in England and in some cases automobile transportation. In most cases, one of the company men accompanied me.

I had several discussions with Dr. Grant and Messrs. Acton and Reid. I found that Mr. Reid and Dr. Grant, at the request of the Turkish Government, had made two trips to Turkey in connection with projected mills to pulp cottonstalks and/or wheat straw. Mr. Hayrullah Gurtan, an engineer of the Industrial Development Bank of Turkey, had visited the Northern Laboratory prior to my Rome assignment and had discussed this problem with us. We had said that straw was preferable to cottonstalks as a fine paper pulp source and had discussed the methods of pulping both of these materials. I learned that Dr. Grant and Mr. Reid had the same viewpoint that we had expressed. They were of the opinion that, because of the economic situation in Turkey, the pulping of cottonstalks using alkaline-pressure pulping methods would prove a paying venture.

During my London stay, Lyddon received a request from the British Government to make an investigation in the Island of Mauritius, a British possession located off the east coast of Central Africa, of the possibility of producing fine papers from bagasse to supply Central and Northeast African colonies. The problems of depithing and pulping bagasse were discussed as well as problems relating to storage. I had an opportunity to examine a small sample of Mauritius bagasse, which was rather short fibered and high in pith. Mr. Reid was flying to Mauritius on about January 20. We have heard nothing further concerning this project.

It will be recalled that Dr. van Nederveen of the Vezelinstituut in Delft, Holland, had been studying the pulping of esparto by the mechano-chemical process. This was being done for Lyddon under the direction of Dr. Grant. I discussed this subject with Mr. Acton and Dr. Grant. From them I gained the impression that some of the pulping had been at 6 percent consistency because of lack of power in the 3-foot Hydrapulper. I recounted the discussion with Dr. van Nederveen. Dr. Grant said that a good many of the esparto mills in England and Scotland were in need of modernization and it was his thought that with the lower amount of alkali required and the higher yield of esparto pulp possible by the mechano-chemical process this might be a means of modernization at low cost. I voiced the opinion that the quality of the pulp, particularly the low bulk and high opacity obtained in the British mills, could not be obtained with the mechano-chemical process. The established British conditions of pulping esparto produced a pulp of low pentosan content due to the action under pressure cooking of the concentrated caustic cooking liquor (20 to 25 percent on basis of straw). While the yield was only about 40 percent, the pulp could be bleached in one stage with about 3 percent chlorine as bleaching powder to a brightness of 82+. The mechano-chemical process, with its much milder pulping conditions, produces high pentosan-containing pulps in yields of about 50 percent. However, to obtain pulps of a brightness of 82+, a three-stage bleach system would be necessary. Dr. Grant said the British mills discussing the matter would not consider the expenditure necessary for installing a three-stage bleach system. Since my return, correspondence with Dr. Grant confirms our conclusions, although Dr. Grant expects to explore the possibility further with the idea of producing a different pulp from esparto.

I was surprised to find that although we had showed Dr. Grant bleached straw pulp in Peoria he doubted that the mechano-chemical process produced pulps that could be bleached commercially. I was able to exhibit samples of 100-percent bleached straw and 100-percent bleached bagasse papers made at the Forest Products Laboratory and told Dr. Grant that while the pulps had been made at Peoria they had been bleached in the Forest Products Laboratory's pilot bleach plant in lots of 200 pounds. Dr. Grant has recently published an article "Non-Conventional Pulping Methods" in the Technical Convention Number of the WORLD'S PAPER TRADE REVIEW, March 1953, in which he now recommends the use of the mechano-chemical process over former conventional pressure-pulping methods for use in making bleached pulps from cereal straws, grasses, bagasse, and similar plants. At the time of my visit he was of the opinion that, if asked, he would recommend the neutral sulfite method for producing bleached pulps from these residues.

Cellulose Development Corporation, Ltd. Pilot Plant, located on plant site of William Nash and Company, Ltd., St. Pauls' Cray, Kent. Col. William Nash, Chairman of Board of Directors of CELDECOR and President of William Nash and Company, Ltd., Mr. C. B. Tabb, Technical Director of the Pilot Plant, Mr. G. W. Legg, Assistant to Mr. Tabb.

Prior to our trip through the Nash paper mill and CELDECOR pilot plant, we had a discussion in Col. Nash's office of straw problems in various countries. We discussed the reasons for the "slowness" of straw pulps. Col. Nash said that when Dr. Pomilio first developed his pulping process it was planned to screen out the nodes but that this was found to be too costly. He said further that it was the idea of the CELDECOR process to produce a pulp of such freeness that it would require no beating in the paper mill. The freeness of the bleached washed pulp in the pilot plant was 38 S.-R., which is about the freeness of our own beaten straw pulps. Col. Nash uses the bleached pilot-plant straw pulp in his paper mill and I believe that he does want a slow pulp for blending. On the other hand, since all of the CELDECOR plants produce slow pulps, this characteristic must be attributed to the process.

William Nash and Company, Ltd. produces only very fine papers. One machine was making currency paper for Pakistan from 100-percent bleached rag pulp. Another machine was producing "ozalid" paper. This was made from a blend of 25 to 40 percent of bleached straw with bleached Swedish sulfite pulp. In the manufacture of ozalid paper, it is necessary to avoid even traces of S or Cl in the pulps. For this reason the straw pulp used was bleached only to a cream white in one stage with NaOCl, followed by thorough washing.

The CELDECOR pilot plant has a capacity of 5 tons of pulp per day. Its location on the Nash plant is ideal since Nash takes the production of pulp and has available all the services required by the pilot plant. It had not been planned to operate the plant the day of my visit, but out of courtesy the plant was put into operation.

The operation and flow of the plant was much the same as described at "Sove," although the appearance, engineering, and control features were not so good. We noted a strong odor of ammonia coming off the top of the caustic digestion tower, which I believe may have been due to the presence of wheat grains in the straw. The pulp coming from the screw press was drier (about 30 percent dry) than the pulp at "Sove." The "opener" also did a better job than the "Sove" opener. Using dryer pulp it would be expected that the temperature during the chlorination step would be higher than using wetter pulp. The chlorination towers were noticeably warmer to the hand than those at "Sove."

The pilot plant houses a control laboratory and research laboratories which are quite ordinary and do not compare with up-to-date research laboratories in American pulp mills.

Mr. Tabb has been associated with CELDECOR almost since its organization in England by Mr. Becker. After Mr. Becker's death, Mr. Tabb has been in charge of development and has assisted in starting up the "Sove" plant and also the new plant pulping bagasse in Pakistan. Both he and Mr. Legg are young men with good personalities and seem to be alert.

The British Board and Paper Research Association, Kenley, Surrey. Dr. R. N. Hood, Director of the Association, Dr. R. S. Jobin, In Charge of Pulping Research and Pilot Plant, Dr. Allison, In Charge of Pulp Testing and Bleaching, Dr. W. E. Bennett, Physics (A) Paper Machine Formation, Sheet Forming Operations, Dr. Emerton, Physics (B) Optical Methods, Electron Microscope.

We went by automobile from St. Pauls' Cray to Kenley, arriving on a very foggy afternoon, the fog being so bad that I returned to London by train. This association, which is supported by the British paper industry, was organized five years ago. Their first quarters were destroyed by fire and they have only shortly located in new quarters in several buildings, formerly housing a boys' school. The setting in the rolling hills of Surrey several miles distance from the town of Kenley is charming.

We met Dr. Jobin, who had visited Peoria, and Dr. Hood, who was leaving the laboratory for another engagement, after which we had tea and a discussion with the group leaders, then made a tour through the laboratories and discussed research work briefly. The association staff consists of about 30. About 20 students are employed, most of whom were then away working on special problems in a good many mills. The laboratory is extensive and very well equipped. I was informed that none of the staff has had any direct paper-mill operating experience and the men I talked to seemed to have very little industrial interest. The projects are to a considerable extent theoretical and of a fundamental character, although they stated that mills were assisted by the association on certain operating problems. The association is set up something like the Institute of Paper Chemistry and seems to have good industry support and is well considered.

Dr. Jobin was interested in the mechano-chemical process when he visited Peoria. However, a report which he made to the industry later concerning this process showed that he did not fully understand it. We had corresponded with him about this and I discussed the subject with him when we visited his pilot plant. It developed that he did not have a Hydrapulper in his pilot plant, but had instead a stainless-steel tank about 2-1/2 feet in diameter provided with a high-speed propeller agitator. It was immediately evident why his results in pulping straw were not as satisfactory as those we obtained in Peoria. I told him we had investigated various high-speed stirring devices and rotors of various sizes and design.

I assured him that it was not possible to obtain the same results with his pulper as with a properly designed one, such as the Hydrapulper. He seemed unconvinced. I learned that Dr. Grant was a member of the board of directors of the association and discussed with him the harm that would be done if Dr. Jobin continued to refer to his pulper as a Hydrapulper. Dr. Grant agreed and said that he would see that this situation was remedied. Dr. Grant has since written me stating that a clear understanding has been reached with Dr. Jobin and the association in this respect. The other pulping equipment is not so extensive, flexible, or as good as our setup in Peoria.

Considerable attention has been devoted to the bleaching of straw and esparto. Some of the work has proceeded along lines explored in Peoria. The Bauer-McNett fiber classifier is used to fractionate unbleached pulps. These fractions were bleached separately when it was found that the fine fibers required more severe conditions for bleaching. This confirmed our work and supports the contention that pith in bagasse is responsible for the difficulty in bleaching pulps made from whole bagasse. As we have discovered, it was found also that the fractions having long fibers produced very strong paper sheets. Studies were being made on bleaching "Hydrapulper"-pulped straw, but bleach requirements were higher and yields of bleached pulp were lower than pulp cooked by the Northern Laboratory method because the conditions during pulping were not comparable.

Studies on the coating of paper with starch, which are designed to give a waterproof finish under alkaline conditions which do not require a high "curing" temperature, were under way. The best results have been obtained with starch and urea resins, but even these are not wholly satisfactory.

Work is directed to finding practical means for manufacturing moldproof papers. Chlorinated phenols and organic mercurials appear to be the most attractive chemicals to use. These are now in use for similar purposes in the United States.

Means for providing vapor resistance to papers are being investigated. Special conditioning cabinets have been built for this study.

The problem of disposal of pulp or paper-mill effluents has always been acute in Scotland and England except for mills located on the sea. Like the situation in the States, that in Britain is becoming more acute. Means of decreasing the B.O.D. of the effluents as well as methods for the recovery of pulping chemicals are being further investigated at the request of industry. Methods for improving efficiency of pulp washing are receiving particular attention.

One of the most interesting studies under the direction of Mr. Bennett is concerned with what happens in forming a sheet on a paper-machine wire. Dr. Bennett has had an opportunity to study several of the

factors on a paper machine in a nearby mill. The results obtained are analyzed statistically. A number of important variables change their values and relationships coordinately as the sheet is formed. He already has information which shows that what we call the freeness of the pulp has no bearing on sheet formation after the wire has passed over a few table rolls. The information so far indicates that the theories advanced are not adequate to explain the behavior of stock on a paper machine. It is believed that enough information has been obtained, as the result of the experiments, to be of definite practical value to paper-machine builders and operating mills. This appears to be a very worth-while project.

A Beck universal microscope incorporating phase-contrast illumination was being used to distinguish the primary and secondary walls of pulp fibers. An electron microscope of British make has been installed and was being used in an investigation of esparto fibers. The electron microscope is also used in an extensive study that is being made of the physical changes taking place in fibers during the beating operation.

In this connection a study is being made of the contribution made to sheet strength by the chemical composition of the fibers, e.g., cellulose, uronides, pentosans, and hexosans. Work is under way to find a method to separate the hemicelluloses into their components and determine these as pentoses, hexoses, and uronic acids. Chromatographic methods are being used. The association is working with Dr. Hirst on this problem.

Another problem of practical interest to papermaking is a determination of fiber compressibility. This investigation is in the exploratory stages.

I was extremely well impressed with the group leaders and with the fundamental approach to the complex problems as yet unsolved in the art of papermaking.

<u>Millspaugh, Ltd</u>., Asling Road, Sheffield. Mr. R. C. Heys, Managing Director, Mr. H. V. Dearden, Director (who had visited Peoria), Mr. Priestly of the London office, Mr. Mowbray of the Paris office, Mr. Harry Currie, Manager of Research (who had visited Peoria).

This organization is one of the outstanding manufacturers of paper-mill machinery. Because of this and the fact that Millspaugh builds pulpers that might be suitable for use in the mechano-chemical process, this company has become interested in the Northern Laboratory development work. Messrs. Dearden and Currie had both visited in Peoria. I had planned to visit the Straw Pulp Manufacturing Company at Radcliffe, which is located between Sheffield and Manchester. Mr. Reid of Lyddon suggested that I could arrange to visit the Millspaugh group, who were anxious to see me, and the Radcliffe mill on the same day. Since he had business both in Sheffield and Manchester, he would like to accompany me.

Millspaugh has contributed several outstanding developments to the paper machine, their latest one being the "suction pickup," a device that has just been installed on one of the large United States newsprint machines. This is a new method of picking the wet pulp sheet off the paper-machine wire. Newsprint is now being formed on wires running at 1,750 feet per minute and sanitary tissue at 2,000 feet per minute. Mr. Heys believes that with the new pickup and other improvements, paper machines can reach a speed of 4,000 feet per minute before serious mechanical problems interfere. I discussed the causes for the slow draining characteristics of straw and bagasse pulps with this group who were very much interested because of their problems of paper-machine design. This group expects to build machines for many of the new installations which will pulp residues and tropical woods.

Mr. Currie has set up a pulping laboratory, particularly to study the pulping of tropical hardwoods and residues. In connection with the mechano-chemical process, Millspaugh was building a 3-foot Hydrapulper especially designed for the process. The Lyddon and Millspaugh organizations are associated in a joint company, Pulp and Paper Research, Ltd., that is promoting the building of new pulp and paper mills all over the world. Millspaugh is interested in the building of machinery and Lyddon the sale of pulp.

Yates Duxbury Paper Mills, Bury, Lancashire. Mr. Geofrey Duxbury and his brother.

Mr. Reid asked me to stop at this mill because the management was interested in experimenting with the mechano-chemical process for producing straw pulp. Bury is located on the way to Radcliffe. Mr. Currie, who had been discussing the process with the Messrs. Duxbury, accompanied Mr. Reid and myself.

This company manufactures fine papers, using a blend of imported sulfite and straw pulp. The straw pulp is prepared by cooking straw in a rotary digester with about 20 percent caustic soda on the basis of straw used. The straw pulp is bleached in one stage with hypochlorite. The straw pulp is claimed to have a freeness of 22 to 25 S.-R., representing a free pulp.

Mr. Duxbury has a 6-foot Hydrapulper. I pointed out that the holes in the extraction plate would have to be covered, using a thin steel sheet, that the pulping must be at high consistency, and that with the increased yield they could not expect to obtain a pulp of the required brightness by one-stage bleaching. I suggested two stages, using hypochlorite. If the mill was not prepared to make these modifications, I advised against trying the process because failure would result.

<u>Straw Pulp Manufacturing Company</u>, Radcliffe, Lancashire. Mr. John Law, Managing Director, Mr. Hood, Chemist.

Both Messrs. Reid and Currie accompanied me. This mill was built during the war to produce cellulose for the manufacture of explosives and was then sold to private industry.

Mr. Law first discussed their process from a large mechanical flow panel in his office, with each station marked by red lights. Mr. Law believes that ample straw is available and that the problem of procurement is largely one of organization and management. At this mill I saw the first straw stored in the open, excepting a small pile at the wallboard mill in Holland. I was impressed with Mr. Law's viewpoint; he seemed to be realistic and to recognize the problems for what they really are.

At first the mill had installed and used an elaborate and costly system for chopping and cleaning straw. This system resulted in a loss of 30 percent of their straw. This practice was discontinued and now chopped straw is only dusted over screens.

In the pulp mill, eight 14-foot rotary digesters are in use. Chopped straw is sprayed with hot caustic liquor, but the straw is not tamped into the rotary. A digester holds 8 tons of air-dry straw. The cooking conditions are 6 hours at 165° C. using 16 to 17 percent caustic soda. Under these conditions the nodes are pretty well cooked and there are not many screenings. All screenings are returned to a succeeding cook. I told Mr. Law that in our experience with pressure pulping of straw using caustic soda, his conditions were too drastic, and that he was unnecessarily reducing yield, and at the same time chemically hydrating the pulp to make it slow draining. Later in discussing this subject with Dr. Grant, he said that in his opinion the conditions were about right for obtaining a straw pulp which could be bleached to a high white in one stage. There is the difference in viewpoint between American and English and European practice. In the United States we have learned how to prepare high yield, strong, free pulps which are bleached in three, five, or even seven stages. This procedure results in considerable over-all economies. Abroad, the papermakers are thinking in terms of slow running machines, pulps low in pentosans, and only one stage of bleaching.

The pulp from the digesters is dropped into a pit, diluted to about 2 percent consistency, and is washed on a CELDECOR vacuum washer. Mr. Law likes this washer very much; it has a low feed pickup giving a long arc for washing, there being four rows of water showers in use. The washing removes 98 percent of the soluble matter from the pulp.

The pulp from the washer at about 10 to 12 percent consistency is diluted to 1 percent and passed over CELDECOR vibrating screens, the screen plates having 8-mm. openings and then through CELDECOR centrifugal screens (plate openings 1.5 mm.). Poor results are obtained with this system and it is being replaced with the newest type Jonsson screens with openings 13-cut (0.013") which give a much cleaner pulp.

After screening, the pulp passes through a concrete riffler having movable baffles to facilitate washing. Not much dirt is collected in the riffler. Next the pulp is pumped through a battery of "Dirtec" cleaners. It is then bleached to about 80-82 brightness in two stages with hypochlorite, the first stage supplies about 90 percent of the bleach requirements.

The pulp is produced for another mill of the same company and it is not dried. Two wet machines of conventional design were making the pulp into laps about 25 percent dry. One new Kamyr pulp machine had recently been installed and was producing a sheet containing only 50 percent moisture. This machine had a capacity of 48 tons pulp (bone dry) per 24 hours and had cost $180,000.

The bleached pulp looked clean and white and was said to have a freeness of 28-32 S.-R. Samples of this pulp have been received in Peoria and are being tested. The yield of bleached straw is about 40 percent.

After the mill visit, I discussed the problems further. Mr. Hood has been interested in our neutral sulfite process but has had no real success with it. We have written to him on this subject.

Mr. Law is planning an expansion in production. He states that during the war 320,000 tons of straw of a total production of 500,000 tons was used to make pulp in England; in 1952 only 136,000 tons was pulped. Mr. Law was shortly going to Sweden to discuss new equipment. I discussed the mechano-chemical process.

A problem that must have solution at this mill is stream pollution. A chemical recovery system was being installed in a building under construction. The system consists of five stages of vacuum evaporation, burning the black liquor in rotary kilns, causticizing the green liquors but discarding the lime muds. Consideration is also being given to the installation by Babcock and Wilcox of a Thomlinson furnace to burn the black liquor and to supply all of the process steam for the pulp mill.

Bowater's Lloyd Pulp and Paper Mills, Ltd., Sittingbourne, Kent. Mr. H. M. Archibald, Managing Director (visited Peoria with ECA team), Mr. D. C. Doughty, Manager, Mr. L. C. Walledge, In Charge of Straw Pulp Mill, Mr. L. S. Fordyce, Technical Director.

Mr. W. H. Stanley of Lyddon met me at the Sittingbourne railway station and drove me to the mill. This mill is located near the mouth of the Thames and was in the area of the spring flood.

Bowater's Lloyd is the largest paper and board manufacturing group in England. They have large pulp and newspaper mills in Newfoundland, Canada, and are building a new large newspaper mill in Tennessee. Bowater's has made a serious study of the possibilities of using straw as a source of paper pulp in England and have concluded that straw pulp has a good future. They have built two straw pulp mills at Sittingbourne, one for making corrugating board pulp and the other for bleached straw pulp. Both mills use the CELDECOR process. The board pulp mill was built to try out the process.

In the straw pulp mill, there are two CELDECOR towers 75 feet high and 5 feet in diameter adjacent to each other. The tower producing board pulp is operated as follows: Chopped dusted straw is passed through a bath of 3 percent hot caustic soda into the tower at a ratio of liquids to solids 4:1. It is kept in the tower from 1-1/2 to 3 hours depending on the demands of the board machine. The pulp is washed on an Oliver vacuum filter, refined through claflins and jordans, mixed with waste paper pulp, and run into corrugating medium on the board machine. From this schedule it can be seen that there is very little uniformity in pulping. The pulp from the tower, which I saw, was cooked about 2-1/4 hours and was similar in appearance to that at Cellulose de la Seine. The amount of waste paper used in the furnish is variable and the corrugating board, I believe, was not up to United States requirements.

Although the management admits that cooking control in the tower is poor, they are satisfied with the process and about a year ago installed the complete process to make bleached straw pulp. The same type of straw is fed to the digestion tower but it is treated with a hot 4-percent caustic solution; the straw is cooked at 3.5 percent consistency for 2-1/2 hours. The pulp is washed, put through a screw press, opened, and passed through a chlorination tower as at "Sove." The consistency of pulp from the screw press is 23-25 percent. After passing through the caustic tower the pulp is washed and screened. The rejects from the Jonsson screens are sent to the corrugating board mill, but the rejects from the CELDECOR centrifugal screens are returned to the digestion tower for repulping. In this way much of the node fiber is eliminated from the process. The water from the deckers after the centrifugals is recirculated as at "Sove." The pulp from the deckers seemed to have about the same drainage

rate as that from the "Sove" deckers. The pulp before bleaching is circulated through a cone sand trap settler (said to be not much good) and then through Dirtec cleaners.

The pulp is bleached in three stages, all at 4 percent consistency. In the first stage, 10 percent chlorine is used on basis dry pulp; in the second, 3 percent caustic soda; and in the third, 3 percent bleaching powder. The brightness of the bleached pulp is about 75 and the freeness 33-35 S.-R. A sample of this pulp, accompanied by Bowater's test results, has been received at Peoria for testing. The Sittingbourne mill has 8 paper machines and produces a wide variety of specialty papers.

At Kensley, about two miles from Sittingbourne, Bowater's operates a very large newspaper mill. I paid a brief visit to this mill to see the largest paper machine in the world making newspaper. The machine produces a trimmed sheet of paper 300" wide. The machine has a speed up to about 1,600 feet per minute but was running only about 1,100 feet per minute the day of my visit. The paper being made was not of very good quality, being dirty, and of poor formation. This mill grinds part of its pulpwood. A portion of the mechanical pulp is imported from their Canadian plant and they purchase Scandinavian mechanical and sulfite pulp. This mill has five large paper machines. The mill is laid out for a sixth newsprint machine which is designed to have a trim of 296".

<u>Colonial Products Advisory Bureau</u>, Imperial Institute, South Kensington, London, S.W.7. Dr. J. R. Furlong, In Charge of Plant and Animal Investigations.

Dr. Furlong was the British representative at the FAO conference in Rome. This institute has published many papers concerning the pulping characteristics of a wide variety of trees, grasses, and other plants, and I was anxious to see their facilities and understand their assignments.

The Imperial Institute was built in 1887 to commemorate the Golden Jubilee of Queen Victoria and was completed in 1890. The buildings are very large, the rooms and halls have high ceilings, and the halls are filled with all manner of display cases. The offices and laboratories are not modern.

Dr. Furlong's division makes chemical and physical investigations on all sorts of products, mainly raw materials from the far-flung British Colonies. Their field of investigations, as may be imagined, is most extensive. In addition to analytical investigations, they carry on certain process investigations on a large laboratory scale and act to answer all manner of questions concerning raw materials, not only from the scientific but also the economic viewpoint. The staff, however, is not large, less than 50 as near as I could judge.

The laboratory for evaluating raw materials for pulp production is not adequately equipped to carry on modern pulp evaluation methods. Dr. Furlong is equipping the laboratory to make tests according to standard TAPPI methods. The staff on this work consists of young men with no industrial experience.

On the other hand, there is a wealth of preliminary information on cellulose sources in the files of the institute. In the files will be found a sample of the raw material with the local and botanical name, samples of the pulp sheets made, and a report of the test results. This file probably covers the widest variety of plants of any in existence.

While the institute carries on its investigations for the direct benefits of the British Colonies, its results are open to all. Dr. Furlong said that at any time his division will be glad to assist us in answering questions about new or strange raw materials.

British Paper Trade Journals

Hearing that I was in London, representatives of the two leading trade journals called to see me. These were Mr. E. P. F. Dean, assistant editor, WORLD'S PAPER TRADE REVIEW, Bank Chambers, 329 High Holborn, London, W.C.1, and Mr. Don, assistant editor of THE PAPERMAKER AND BRITISH PAPER TRADE JOURNAL, Graham House 3, Tudor Street, London, E.C.4. I discussed the character of our work, the situation concerning agricultural residue utilization, and the Rome conference with these gentlemen.

I had hoped to see the operation of the Morley process for producing corrugating pulp from straw at the Thames Board Mill but was not able to make arrangements. I had also hoped to meet a number of leaders of the paper industry with whom we had corresponded, but none of these people were in London during my stay.

E. C. Lathrop, Head
Agricultural Residues Division

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